AMATEUR WORK

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WOOD AND METAL XYLAPHONES.

The xylophone and harmonica are musical instruments that have been in use, probably, for thousands of years. The xylophone, known also as the gigelire (pronounced je-je-le-ra, Itaiian for fiddle-lyre), sticcada, and straw-fiddle, is a wooden dulcimer, while the ordinary harmonica is a metal or glass dulcimer. A set of wine glasses played by rubbing the fingers round the rims, is also called the glass harmonica, musical glasses, or glass orchestra. The name "xylophone" is occasionally aplied to an arrangement of upright wooden resined sticks from which musical notes are produced by rubbing with a resined glove; a convenient name for this instrument is the "wood harp."

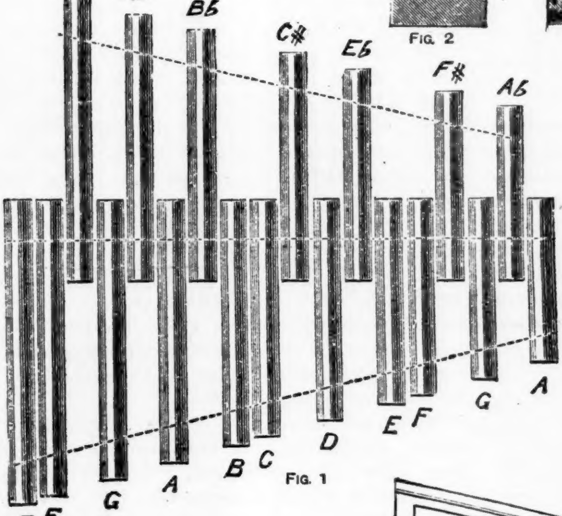


FIG. 1


FIG. 2


FIG. 3

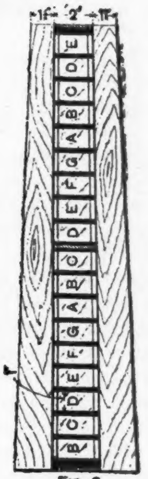


FIG. 6

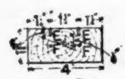


FIG. 8

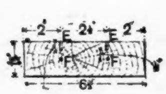


FIG. 9

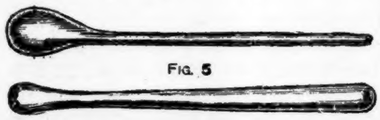


FIG. 5

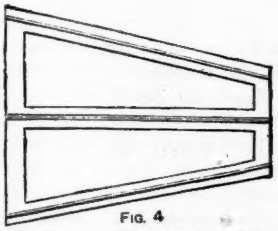


FIG. 4

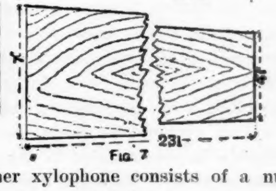


FIG. 7

The wood dulcimer xylophone consists of a number of pieces of rosewood, arranged in the manner shown in Fig. 1; these pieces form the notes, and are slung together with whipcord. They are laid on three straw ropes to insulate them, the straw ropes being fixed

on a frame. The notes are played by two boxwood beaters, the player standing in front of the naturals, and playing the air with the right hand and the bass with the left hand. The xylophone may be played as a solo instrument, or with piano or other accompaniments; and in the hands of a skilful player some very good effects may be got from it. The rosewood notes are 1 1/8 in. wide and 5/8 in. thick, rounded on the top side as shown in section by Fig. 2. The middle C will be approximately 5 3/4 in. long. The addition of five notes at the lower or left-hand end down to C, and five at the top end up to D, is recommended. This will give it a compass of two and a quarter octaves, making the lower notes correspondingly longer and the top ones shorter. If rosewood cannot be procured, oak or pitch pine may be substituted, and to make the tone more even they should all be cut from the same plank; they should also be free from knots. A hollow 1/2 in. wide and 1/8 deep is cut across the under side of each note in the center. Bore holes 1 1/2 in. from the ends of the longest notes, and 1 in. from the ends of the shortest notes, for the cords to pass through, as shown by the doted lines in Fig. 1.

Three pieces of whipcord are passed through the holes, and the center one may have knots made between each note, to keep them apart. The ends of the cords are put through a small washer or button, and knotted.

The straw ropes are about 7/8 in. in diameter, and are made in the following manner. A quantity of good clean long straw is procured and the heads cut off; then draw it through the hands to straighten it, and take out the short straws. Then bore a 7/8-in. hole in a piece of wood, and fill it tightly with the drawn straw; push it through for 3 in. or 4 in., and wrap it with narrow red tape (as shown in Fig. 3), winding the tape on as the straw is drawn through the hole, and tie the ends as shown. If the straw cannot be got in long lengths, the ends may be cut angular and the pieces joined together.

The frame is made as shown in Fig. 4, the joints being mortised or half-lapped together; the wood may be 2 in. wide and 3/4 in. thick. The straw ropes are fixed on the top by small wire nails or staples, the heads of which should be below the top of the ropes. The frame is not absolutely necessary,, as the straw ropes can be laid on a table or box; but it is better, especially if the straws are in two pieces, the instrument being then always ready for use.

A case may be made to hold the instrument. The case should be 3 in. deep inside, and the width of the lowest notes; it may be made narrower at the top end. Half-inch pine would do for the case, and it may be hinged on at side, and fastened by two hasps. or a lock. In playing, the frame may be laid on the case, which will improve the tone.

Two half-size views of the beater are shown by Fig. 5. They are made of boxwood, or, if this cannot be procured, lancewood may be used, which can be got from a broken gig-shaft. They are shaped as shown, with chisel and rasp, and smoothed with glasspaper.

The notes are tuned to a tuning fork or piano. They should be cut rather longer than they will untimately be, and raised in pitch by cutting a piece off the ends; but this must be carefully done, as if too much is cut off the note will be too high in pitch. It will be best to tune them before fastening them together, and, if one is made too high, it can be moved a note upward. The rounded tops of the notes are varnished, to improve their appearance.

The glass harmonica (Fig. 6) consists of strips of plain glass, which are played by being struck with a beater. Take a piece of 3/8in. pine of the shape and size shown in Fig. 7. Proceed to make a box of this by gluing to it on each side a piece 23 1/2 in. long by 1 3/4 in. wide and 1/4 in. thick. For the wide end a piece of 1/2 in. stuff, 1 3/4 in. wide by 6 1/2 in. long, will be required; and for the narrow end a piece 4 in. by 1 3/4 in. by 1/2 in. These must have two slots cut in them, as shown by Figs. 8 and 9. These slots are 3/8 in. deep, and are 2 in. from each side at the wide end and 1 1/4 in. at the narrow one. Glue across the center of the box a piece of wood to act as a bridge. The top of this must be 3/8 in. below the top of the sides, and must not touch the bottom of the box. In Figs. 8 and 9 E shows the slots, and F two small panel-pins, one of which is inserted at a distance of 1/2 in. below each slot. Take some trong fine silk or chochet cotten and tie one end securely to one of the pins. Bring the end through the slot immediately above the pin, carry it over the bridge and though the opposite slot, wind it around both panel-pins at that end, take it back again through the slots, and fasten it off securely. These strings must be stretched as tight as possible. Cut the glass into strips, 1 in. in width, and attach them to the strings by drops of sealing-wax. The box will hold eighteen strips, which should be in the key of C, and range from B to E.

Before fastening in the glasses, simply lay them on the strings and try them, changing them about until their proper places are found. To sharpen a note, cut the glass a trifle shorter.

For glass 1 in. wide and 1/16 in. thick the following will be about the correct lengths:—B, 5 1/2 in.; C, 5 1/4 in.; D, 5 in.; E, 4 7/8 in.; F, 4 5/8 in.; G, 4 1/2 in.; A, 4 3/8 in.; B, 4 1/4 in.; C, 4 1/8 in.; D, 3 3/4 in.; E, 3 5/8 in.; F, 3 1/2 in.; G, 3 3/8 in.; A, 3 1/4 in.; B, 3 1/8 in.; C, 3 1/16 in.; D, 3 in.; E, 2 3/4 in. When the glasses are turned and fastened to the strings, procure two pieces of 3/16-in. deal or pine, 23 1/2 in. long by 2 in. wide at one end and 1 1/4 at the other. Glue these on so as to hide the ends of the glass strips and form a top to the box.

For the beaters procure a piece of thin cane or, whalebone about 8 in. long, and glue on one end a

round knob of cork. The instrument is played by tapping the notes with the beaters, holding one in each hand, and grasping them about 1 in. from the end to let them have plenty of spring.

In arranging a set of musical glasses (see Fig. 10), one of the most important things to aim at is simplicity of construction, so that the notes may be brought well under the hand and can be reached without trouble. Fig. 10 shows a simple arrangement of the glasses, as it brings the semitone of each note next to the note itself. If of the plain dulcimer shape, the sides and ends of the case may be made to fold down and under, or the apparatus may be made as

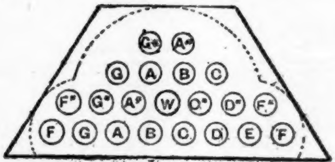


FIG. 10

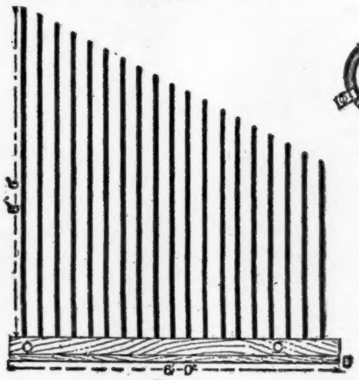


FIG. 12


FIG. 11

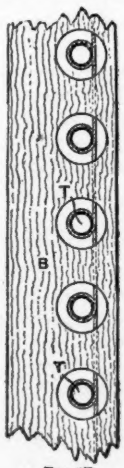


FIG. 17

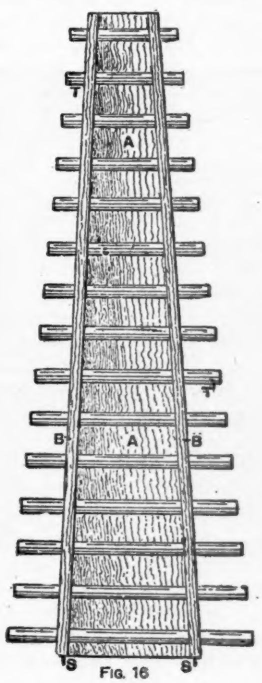


FIG. 16


FIG. 13

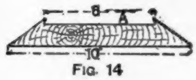


FIG. 14


FIG. 15

shown by the dotted lines. Note that the water glass for moistening the fingers is placed in the center; the water glass usually contains water that has been acidulated with lemon juice. The best kind of glass to use is the plain flint; and it is obvious that the glasses cannot be all of one size, as the necessary difference in pitch will not admit of it, but it will be well to get them all of the same height if possible. As they cannot be raised in pitch, any tuning necessary must be obtained by flattening. This is done by putting water into each glass till the desired note is attained. Do not flatten any glass any more than a whole tone, as it spoils the quality. The glasses are fastened to the baseboard b means of clips —three to each, as shown in Fig. 11.

The wood harp is shown by Fig. 12. In making this instrument, the wood must be carefully selected, because shakes or knots seriously impair the tone. Also the parts must be carefully fitted. For the foundation take a piece of well-seasoned deal, 6 ft. long and 6 in. wide, and about 4 in. in thickness. Plane this up to the size and shape down by FFig. 13. The rods are 1/2 in. in diameter when rounded up. The longest will need to be about 6 ft.;; all must be evenly planed and glasspapered. At 3 1/2 in. from one end of the foundation, bore a hole 1 in. deep with a centre-bit. This hole should be slightly less in diameter than the rods. Bore similar holes right along the centre of the foundation at distance of 3 1/2 in. apart. Slightly taper one end of the rods, and, after dipping them in good hot glue, drive them well home with a mallet. After putting in all the rods, leave them to dry for 24 hours. Proceed meanwhile to make the stand, which will require a board 6 ft. by 10 in. by 1 1/4 in. Plane this up to the section shown by Fig. 14. This is for the foundation to fit in at A. This stand is fastened to the foundation with 2-in, screws from the bottom. Fig. 15 shows the end in section, B being the rod, C the foundation, and D the stand. When thoroughly dry, rub down with glasspaper;; then take an old glove of wash-leather and dust it well with powdered resin. Take hold of the longest rod with a light but

firm grip, and draw the hand down. Try this until the best effect is obtained; then proceed to tune all the other rods from this one by cutting them down bit by bit until the desired notes are produced. Keep the wood harp very clean; do not stain, varnish or paint it. When the resin has worked into the rods a little, they will sound at the slightest touch. With a little practise a great many airs can be played. Never touch the rods except with the resined gloves.

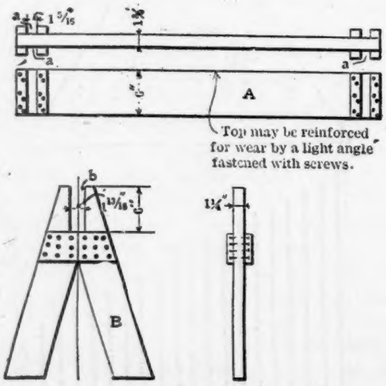
The tubephone, shown in plan by Fig. 16, is related to the harmonica. The following instructions apply to the making of a two-octave tubephone (fifteen notes) in the key of G. For the baseboard A, get a piece of 1/2-in. pine, free from knots and shakes, 23 in. long and 4 1/2 in. wide at the base end, tapering to 1 33/4 in. at the upper end. For the two sides B or bridges to carry the tubes, two pieces of pine, 23 in. long by 3/8 in. thick, will be required. The width of these depends upon the way they are joined to the base, whether fastened to the sides or tops. In either case they must stand 1 5/8 in. above the baseboard and 4 1/2 in., tapering to 1 3/4 in., apart, inside measurement. These bridges are bored with 7/8-in. holes on centres 1 1/2 in. apart, as shown in an enlarged portion of side (Fig. 17) for the tubes to be suspended in. The tops of these holes should be cut to a line gauged 3/16 in, from the top of the bridge. A stout saw kerf or narrow groove must be taken the whole length of the bridge along the top, to allow a soft cotton cord to lay in to support the tubes. This groove must be cut to a depth of 3/8 in., and will then support the tubes about the centre of 7/8-in. holes. The tubes T are made of thin brass 3/8-in. bore and 7/16-in. outside diameter, sound and free from cracks.

The lengths of tubes given below are approximately correct, but the slightest difference in thickness or weight of metal will cause veriations in pitch. As a tube cannot be flattened in pitch, cut them long enough in the first instance:—G, 9 3/4 in.; A, 9 1/4 in.; B, 8 3/4 in.; C, 8 1/2 in.; D, 8 in.; E, 7 1/2 in.; FS, 7 1/8 i n.; G, 6 7/8 in.; A, 6 1/2 in.; B, 6 1/8 in.; C, 5 7/8 in.; D, 5 5/8 in.; E, 5 1/4 in.; FS, 4 15/16 in.; G, 4 3/4 in.

To fasten the tubes in position, secure one end of the cotton cord to the base end of the bridge below the groove with a staple, screw, or nail at S, and lay it in the groove right along to the upper end; the cord will then show as a line cutting the 7/8-in. holes about 3/16 in. down. Draw the cord down in the hole, pass one part behind the other to make a bight, and insert the tube. When all the tubes are in, tighten the cord and fasten the end as before. The tubes can now be regulated to lie fairly in the centre of the holes without touching the sides. Finally, glue a thin strip of wood into the groove in the top of the bridge, and stain and varnish, or polish, as desired. The beaters are made of wooden balls about 1 in. in diameter, on thin flexible cane sticks 8 in. long. A good plan is to have the baseboard about 1 in. wider than the length of the tubes, and to make a wooden box or cover to fit over all; this will keep out dust and dirt and prevent damage to the tubes.—"Work," London.

A FOLDING TRESTLE.

Herewith is a sketch of a tressle which may be readily taken down and stored away in some small corner of the shop, writes W. E. Morey in the "American Machinist."



The top bar or rail A is provided with grooves near each end, formed by nailing strips of wood on each side as shown at a a a. The legs, one of which is shown at B, has a space b at the top which is a pretty close fit over the top bar, and the strips on each side of the top bar are a close fit on the upper end of the legs. This trestle is not so useful in the machine shop, possibly, as in some other lines, but its collapsible feature is perhaps worthy of your attention. It is certain that the old form of trestle is a very unhandy contrivance to store away when not in use.

The method of drilling holes in glass plates is to take an old twist drill, see that it is properly sharpened, and harden it by beating the point to a cherry red over a gas flame, and quench in ordinary soldering "acid," that is, chloride of zinc solution. Use this drill in the ordinary way in a bit brace or hand drill, lubricating the point with turpentine. A quarter-inch hole is very easily made in this way. Then take a medium coarse rat-tail file, moistened with turpentine, and the hole may be enlarge to required size in a few minutes. Care should be taken not to get the file stuck in the hole while it is still small.

Try this on a waste piece of glass first. If the drill gets dull it must be ground and then hardened again.

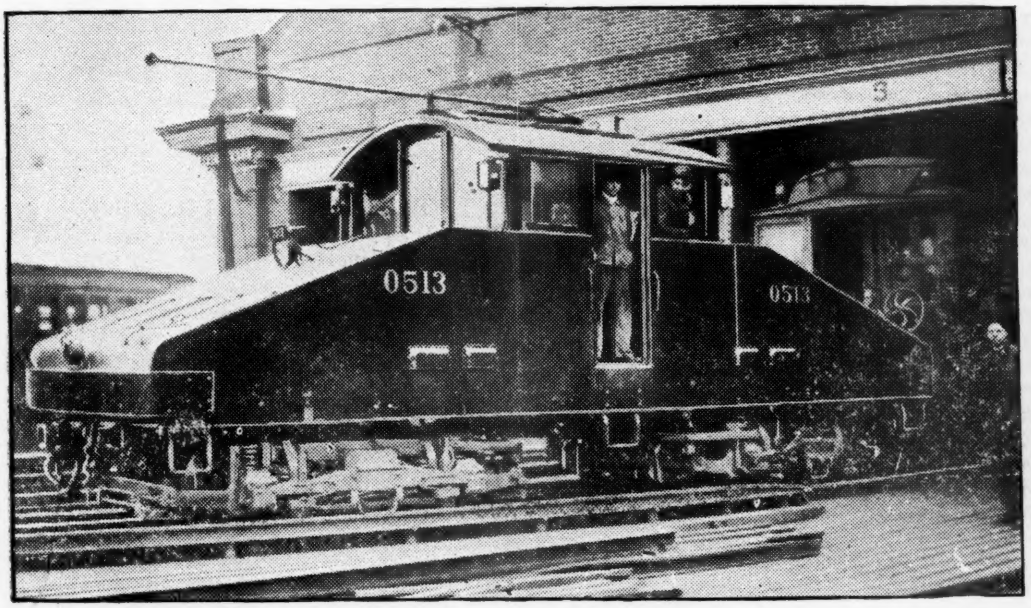
POWERFUL ELECTRIC LOCOMOTIVE.

One of the two powerful electric locomotives recently designed by the Boston Elevated Railway company for heavy yard and general haulage service on the elevated division has already been completed and is at work in the Sullivan-cq. terminal yard, Charlestown, and the second is in process of construction.

Both locomotives will have been manufactured in the company's own shops and are practically duplicates. One will probably be used more exclusively in yard work, while the other will be employed in the haulage of materials, flat cars, box cars or other rolling stock in connection with the work of the road department.

Each locomotive is 30 feet 7 1/4 inches over all and 8 feet 7 inches wide. The hight of the top of the cab from the rail is 11 feet 3 inches. They were designed to pass through the subway as readily as a standard elevated car and each weighs 77,000 lbs. The floor is a trifle above four feet above the rails.

In general design the locomotive conforms to the usual arrangement of a central cab and body with sloping ends on each side, supported on a heavy underframe, the latter being carried on two four-wheel trucks. These trucks are similar to the motor trucks used under the cars of the elevated division, having 24-inch steel tired wheels, a six-foot wheel base, and being 16 ft 3 1/2 inches apart on centers.



The contractors are mounted in a fireproof compartment in the centre of the cab, which is about eight feet long. The master controllers are mounted in diagonally opposite corners of the cab and are arranged for right hand operation of the locomotive, facing each end. The reverser, circuit breaker, fuse box and rheostats are installed under the sloping end at one side of the cab, and the main reservoir cylinders, air compressor and governor are installed under the opposite end. The wooden flooring is fireproofed by sheet tin in the compartment which holds the control apparatus.

Minor control switches and fuses are mounted in a special asbestos lined compartment at one end of the cab and a single-pole, double-throw switch is installed to connect the main motor circuit, either with the trolley pole, with which the locomotive is provided, or with the circuit of the third-rail shoes. The air brakes are of the new electro-pneumatic type with graduated release and quick recharge features,

Ark headlights and electrically lighted markers are provided, and part of the space at each end of the locomotive is given up for tool box purposes.

The locomotive already completed is used in shifting cars in and out of the northern division of the Sullivan-sq. shops for the purpose of wheel grinding or truck changing. About 48 pairs of wheels are ground daily, and the locomotive is constantly at

work transferring cars to and from the special track in the shops.

Ever since electric train operation began in Boston it has been necessary to shift dead cars by a passenger car withdrawn from the service. On this car the facilities for looking back at the rear of the train were not good and safe movements could not be made without considerable delay in signaling. In the locomotive the driver can headily see all that is happening at the end of the train and the control is graduated so that the locomotive can be moved an inch at a time if desired. Eleven elevated cars, weighing about 33 tons each, have been hauled at one time by the new locovotive without the least difficulty.

"WIRELESS" WITHOUT AERIALS.

I have read with much interest in your first issue of March, an article describing the erection of poles towers, etc., for the support of aerial wires in connection with radio-telegraphic apparatus, and in this connection I should like to say something concerning the transmission and reception of telegrams wirelessly, with and without the use of high aerial wires or conductors; writes Gorge S. Piggott in the "Electric World."

For some time past I have been engaged in experimental research with the object in view of ascer-
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taining, if possible, the kind of apparatus necessary for the accomplishment of continuous and perfect transmission of radio-telegaphic pulsations. In using the aerial I have found after numerous and exact experiments that the high wire is comparatively of no value for continuous and syntomic transmission, on account of the cumulative effect of atmospheric electricity on said wire, which effect is more than sufficient at times to operate the receiver, record false signals, and perhaps burn out the apparatus, thus endangering the life of the attendant or operator who might be near.

In consideration of the above I therefore set about to construct apparatus with which I could communicate continuously day or night during stormy or clear weather, without the use of the high aerial and I have succeeded to such an extent that I am perfectly satisfied with results gained.

I may say that I communicate, with great accuracy (as pefectly as by wire) over a distance of half a mile or more in the city of Chicago, with steel constructed and other large buildings intervening, these buildings entirely screening the instruments, which are situated each in its own respective room, on the ground floors, and having no wire or other artificial conductor whatever outside.

The instruments I have are quite crude, and are made up of anything suitable that came to hand; nevertheless they are very effective, when considering the power consumd in oprating the transmitter for the above distance, is not more than 22 watts, and the action of my detector at the receiver is so intense for the given distance, that the pulsations can be heard when the telephone is placed some 8 inches from the ear;; these results being gained with apparatus keighing in entirety not more than 60 lbs.

In conclusion I will state that I can carry my receiver to a building, set in down on a chair, throw a switch, and when a message is to come, a bell will ring, and communication has started; no aerial, or metal cylinders, or analogous conductors being necessary.

(At a demonstration with Mr. Piggott's apparatus in Chicago signals were transmitted at a distance of about 1/4 mile with numerous brick and some semi-steel frome buildings intervening. The receiver was in a small box which was set behind a piano with the idea of getting as much screening effect as possible. The only metallic connection to the receiver was a ground wire attached to a steam radiator. The sending station had no aerial conductor.—Eds.)

ELECTRIC PIPE THAWING.

Electric Pipe Thawing has been successful in Ottawa, Can., according to City Engineer Newton J. Ker. Current is taken from the wires of the Ottawa Electric Light Co. and reduced by transformers to about 25 volts. The company charges $1.50 an hour for current and apparatus. One wire is connected to the service in the house and the other to the stopcock box in the street, an adjoining service or the nearest street hydrant, the object being to have a connection on either side of the frozen section and as close to it as possible. The electric curent sometimes cleared the pipe in thirty seconds, but if the service was long and frozen solid it varied from that to thirty minutes. Where couplings with a leather washer are used at the stopcock boxes the current will burn out the washer and cause a slight leak. Where the coupling used is of brass and lead the current causes no leak and no damage is occasioned the service, except in isolated and difficult cases where more than 25 volts are used.

The amount of steam that may be made with coal depends upon the coal itself, and also upon the conditions under which it is burned. Another important factor is the man who is doing the firing. An inexperienced man can easily waste coal by either too little or too much stoking. Overfeeding the fire results in intense heat, causing waste by blowing off of the safety valve. When fuel is again added to the fire in unnecessarily large amount it temporarily deadens the fire and the steam goes down, only to rise again when the fire burns brightly. Coal making a large percentage of ash is not so good as that making less.

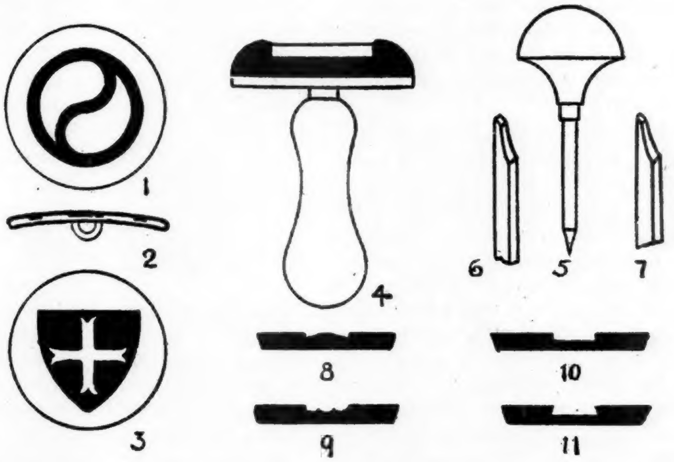
DECORATIVE ENAMELLING.

III. Designs for Buttons in Champleve Enamel.

I enamelling on the method called champleve, the cells to receive the enamel are cut out of the metal by means of scorpers. The metal used should be fairly stout, at least 3/32 of an inch in thickness, and in view of the probability of the enamel being fired in a crucible, the work should be small. Buttons are very suitable for this method of work; although brooches, buckles and clasps may be made, they need more space and should be fired in a muffle furnace. Either copper or silver may be used, and both have a good appearance, especially the copper if it is burnished. The first thing the enameller has to consider is the design to be worked on the surface of the button and it may be either a conventional arrangement of leaves, a flower, or a geometrical form, as shown in Figs. 1 and 2. Another excellent method of ornamentating buttons is to utilize the arms and other portions of heraldry. Fig. 3 is a suggestion for the use of a shield in the centre of the button and ornamented with a cross.

This shield is attributed to the Saxon kings, and the cross is represented charged on a shield azure, the cross being gold. A study of heraldy will give the designer an unlimited store of suitable suggestions for design and so much of it extremely useful in enamelling.

We will take for a commencement the design shows in Fig. 1, and will presume we have a fairly stout piece of copper, cut to a circular shape with a diameter of 3/4 in. The design should be accurately drawn out on a piece of drawing paper, traced on ordinary tracing paper and then transferred with carbon paper to the metal. The metal should be thoroughly cleaned with fine emery cloth before the design is transferred on to it and also should be slightly domed to give a shape to the button. The transferred lines should be scratched with a fine scriber and then should be mounted on an engraver's block or a suitable stand, covered with cement. The cement should be the same used for repousse, and made up of Swedish pitch, plaster of paris, and a little tallow and resin. A very suitable form of stand is shown in Fig. 4, the stand being made out of a bradawl handle, with a square piece of hard wood 3/8 in. thick. The illustration shows a section through the holder showing the metal in position. To mount the button, warm the pitch and press the piece of metal, which should also be warmed, into the pitch and when quite hard is ready to use. The spaces are cut out with suitable scorpers, about half-a-dozen different shapes being useful, but a lot of work may be done with the three shown in Figs. 5, 6 and 7. Fig. 5 is a pointed scorper, Fig. 6 a square, and Fig. 7 a round, and as they need to be kept very sharp, an oilstone or slip should be kept at hand to keep them in good condition. It is better to get the scorpers fairly short, as they are usually too long when new, and it often pays to grind them down short enough to hold in the palm of the hand and reach to the end of the fingers. We will start by firmly holding the stand by the handle in the left hand and rest it against the bench or table. Next hold the scorper; for a start use the pointed one in the right hand, with the arm resting on the bench, the blade between the thumb and forefinger, and the handle in



the hollow of the palm as near as possible to the joint of the little finger. The point of the tool is held at an oblique angle to the work and is guided by the thumb and pressed from the palm of the hand.

The use of the graver is not easy, and the worker will be well advised to practice on an odd piece of copper until he gets into the right way. Before cutting, wet the top of the tool and then make a sloping cut round the borders of the parts to be sunk. Fig. 8 shows the first stages of the cut, the deepest part being just inside the line. Next take the round pointed scorper and take out the middle of the spaces to a depth of 1/32 of an inch. This is done by taking small parings off until the bottom is reached and forms the second stage of the work, as shown in Fig. 9. To finish the bottom of the space, the square scorper should be used, leaving the space as shown in Fig. 10. If the enamel is to be opaque, the bottom of the spaces should be roughened, the edge of the flat scorper being pushed over the ground with a side to side rocking motion, making a zig-zag cut; it makes the enamel hold well, but should not be used with a transparent enamel as a rule, as it gives the ground a mechanical effect, which is unpleasant. The best way of thoroughly keying transparent enamels is to slightly undercut the edge, as shown in Fig. 11.

We will now suppose the cutting finished and ready for the enamel, which should be pulverised, as shown in a previous article. Place the enamel in the cells as suggested for cloisonne, dyry it over a spirit flame, and then make a cradle of sheet iron, pierced with some small holes, to fit underneath the button, and covered with loam or whiting and pipeclay. Place the work in a crucible with the lid on and fire it well, using a blow pipe and bellows, or if a muffle furnace may be used, fire it for preference in it. The cells will probably not be full after the first firing, although filled up with the enamel at first, so they should be refilled and refired until quite full. File up the surface quite smooth with a corundum file, wash the work in a solution of hydrofluoric acid and water, taking care to use rubber finger stalls when using the solution, and then finally refire the work. The finish should be given by means of rouge, thoroughly well polished. The ring underneathe may be soft soldered on, but may, if desired, be soldered on with hard solder before the enamelling is done; in this case the work should be covered with loam or the whiting and pipeclay mentioned above, or a mixture of plaster of paris and borax, otherwise the solder would run during the firing. In making the shield shown in Fig. 3, the cross should be left in the metal and being of a gold color, if made in copper and burnished, the effect will be nearly correct. Proceed in the same way as before, cutting out the whole of the shield with the exception of the cross, and then after roughing the ground, fill in with a deep blue and fire, refilling and refiring until the work is fiished.

In working out other heraldic forms, a silver effect may be worked on copper by using a clear flux over a piece of silver foil and a brilliant gold by using gold foil on a layer of clear flux in the same way. When foil is used it should be pricked ful of fine holes, and the means of doing this is to set a bundle of the finest needles in a cork and use the points as a pricker. If great brilliancy of color is required, it may always be gained by first covering the gound with a layer of clear flux, firing it, and then adding the colors afterwards.

Antimony is a white metal which fuses at a low temperature and is readily vaporized, says the American Machinist. It is of a laminated or crystalline textile and is very brittle. It is used in several valuable alloys, but is not used in the pure state; its most important alloys are type-metal, britannia metal, pewter, and various anti-friction metals. Type metal consists essentially of lead and antimony, with, frequently, the addition of tin, nickel or copper in small quantities. Brittannia is a white-metal alloy much used for table-ware, and consists of antimony, with tin, copper and bismuth. A similar alloy, containing, however, a smaller percentage of antimony, is pewter. The antifriction alloys usually are known as babbitt metals. One of them consists of 30 parts of tin to 5 of antimony and 1 of bismuth, but, as is well known, various proportions are employed. Antimony has a hardening effect when added to lead; a small quantity of bismuth gives the alloy the property of expanding at the instant at which it solidifies, the result being a perfect cast from the mould.

The Use of Copper Sulphate as an algicide and disinfectant in water supplies has been tried practically under so many conditions that definite data regarding it are gradually becoming available. The conclusions drawn from the experience to date by Dr. George T. Moore, who first suggested this procedure, are as follows: Much less copper is required to eradicate algae from reservoirs than is necessary to destroy them under laboratory conditions. The effect of the sulphate on fish is of considerable importance and requires more study. The physical and chemical constitution of a water are factors to be considered in determining the quantity of sulphate to use. The elimination of organisms causing pollution sometimes makes possible the development of other species, but so far the latter have never been the cause of complaint. As a result of the sudden destruction of great numbers of algae, there is sometimes an increase in the odor and taste of the water for a few days immediately after its treatment with copper or sulphate. Under certain conditions the sulphate may be used to great adantage in connection with filtration.

The world uses at least 170,000,000,000 matches yearly.

FITTING OUT YACHTS.

GEORGE H. COLLYER.

Much preparatory work of fiting out can be accomplished early in the spring, long before it is practical to commence work upon the hull, unless the boat is under cover.

Hoops, blocks, oars and such movable fittings as cabin doors, tables, glass rack and tiller or wheel can be carried home and scraped, sand papered and varnished during leisure moments; then when spring fairly sets in and you are anxious to be afloat, you can devote your entire time upon spars and hull.

In scraping the hoops and blocks first remove the accumulation of varnish by using some good varnish remover, allow the woodwork to dry thoroughly, then scrape with a steel scraper or broken bits of glass until the bright wood is exposed; sandpaper until a smooth surface is obtained, then shellac and varnish.

If an especially smooth surface is desired sandpaper with fine sandpaper after each coat of shellac until the pores of the wood are thoroughly filled, then apply two or three thin coats of varnish. Do not attempt to varnish if the temperature is less than 65 degrees, —and allow plenty of time for each coat to dry—and harden. The same directions also apply to all fittings which we have heretofore mentioned, although it is not advisable to use glass in scraping a flat surface, and its use should be confined exclusively to hoops and blocks. If the bright work is mahogany a little mahogany stain applied and thoroughly rubbed off with a soft cloth will improve the effect.

During spare moments overhaul the standing and running rigging; a new sheet or halliard may be needed. See that all rope ends are whipped and splices served; test all turn buckles and examine wire rigging, stay and shrouds. Don't be afraid to spend a cent for new rope, and never use running rigging for more than two seasons; you can never tell when you will get caught in a tight place, and when you do there is a certain sense of security if you know your gear is sound and will stand the strain. In buying rope be sure and get Plymouth, as it is softer, more pliable and free from the splinters which you will find in cheaper brands.

If time will permit, get to work on the tender, you will be surprised to see how long it will take to scrape, paint or varnish this necessary adjunct to a boat, and its "dollars to doughnuts" if you don't do the work before the season opens, it won't be done at all, or in such a slipshod manner that it might better be left undone.

Give your sails the same careful inspection that you give the rigging, and make all necessary repairs or have them made. Do not wait until you get ready to bend them on; then, finding it too late, take a chance with the result that it will cost you a new sail or a patched old one. During your leisure moments you can make a sail cover, a cover for skylight, or an awning, and if you are an expert in using the sewing machine a pennant, burgee or a string of code signals.

As soon as the shores are free from ice it is a good plan to put down your mooring for the season, and while you are about it make it of sufficient size to hold a boat twice the size you intend to moor to it; then you feel secure no matter how hard it may blow and no matter how rough the sea. Make it like the "Parson's one horse shay;" every part as strong as the other. How often do you see a mooring stone large enough to hold a "forty footer," a 7/8 inch mooring chain, and a cable as big round as your arm, while the shackle is not as large as a baby's teething ring.

If you moor in shallow water where your boat grounds at low tide, be sure your mooring is buried in the mud, that no projecting bolt may find its way through your boat's side when she settles at ebb tide. For a small boat a "sucker" mooring is the cheapest and will furnish a secure tie up. Take two planks from a foot to fifteen inches wide and from four to six feet in length, bolt them together at right angles, attach your mooring chain to the eye-bolt and bury in the mud. For a large boat a stone mooring is to be preferred.

If there is sufficient depth of water under your boat at all times and tides, the most satisfactory mooring is the "mushroom." It is easy to put down, easy to take up in the fall, and a mooring which can always be relied upon.

Mooring cans are preferable to kegs, spars or floats for pick-ups, as they will sustain a greater weight and can be more readily handled.

The length of the mooring chain and cable should equal four times the distance from the mooring to the surface at high water, or in other words, if it is 10 feet from the mooring to the surface the chain should be about 10 feet and cable about 30 feet in length. It is well to overhaul the cable occasionally to see if there are any chafed parts or parted strands.

De you moor your boat by a shackle slipped into an eye in the bow as the constant strain upon the stem is sure to loosen the planking, especially so if you are moored in an exposed place where there is a jump of a sea.

Lead your mooring line over the bow through a chock of sufficient size to prevent jamming, and make fast to bits, cleat or shackle to a bridle around the mast. Be sure that that portion of the cable which comes in contact with the bow or bobstay is protected

by strips of canvas wound around it and served with stout marline.

If the spars need attention remove all old varnish, sandpaper thoroughly, apply two coats of shellac, rub down well, then varnish two or three coats. Do not varnish unless the day is fair and warm; if the sun is too hot protect the fresh varnish from the sun's rays or it will blister.

If the wood has become chafed or weather worn, or if you wish to do an "A1" job, go over spars with a spoke shave, then sandpaper, shellac and varnish. Paint all exposed metal parts, such as eye-bolts, gooseneck, withs, shackles, etc., with aluminum paint, if iron rust is showing through the galvanizing.

Now that you have made all preliminary preparations, as soon as the weather settles you may commence work on the hull in earnest. Give it a thorough washing and scrubbing, as the paint will look much cleaner and brighter if all traces of marine growth, mud, etc., are removed.

Scrape and sandpaper the bottom and top sides until a smooth surface if obtained. If the paint is so thick that good results cannot be obtained, it can be burned off by means of gasoline torch or removed with paint remover, but do not attempt it unless you have plenty of time at your disposal as it is a slow and tedious operation, and must be done well or the results will be most unsatisfactory. Fill the seams lightly with white lead putty, then sandpaper the whole surface.

Another bit of advice; don't attempt to paint the hull or draw the water line unless you are an expert with the brush; it is much better to hire some one to do this work for you and the improved appearance will justify the expense. For a bottom paint use a good anti-fouling paint and there are several good brands on the market. For a boat that is moored in deep water all the time "Marblehead Anti-Fouling Green" will give the best results, as it will keep cleaner and resist marine growth longer than almost any other kind of bottom paint upon the market.

In painting the top sides use for first coat white lead and boiled linseed oil well mixed and for a second coat add a little French zinc, as it will give a bluish white surface and counteract the effect of the linseed oil.

Do not buy ready mixed paints, unless you know the brand to be reliable, as many brands are adulterated with cheap mineral oils. If experienced in mixing paint buy your own ingredients, or have your paint mixed by some reliable painter who knows just what proportions to use.

Black paint is not recommended as it draws the heat, blisters, peels and soon looses its gloss.

If your deck, cockpit and cabin house are finished bright, scrape, wash with gasoline and a solution of oxalic acid to brighten the wood, then shelac one coat and varnish two coats, using the best spar composition. Avoid thick and gummy varnishes, as those which spread on thinner will prove more satisfactory.

If, however, your deck house and cockpit are painted, wash the surface carefully, sandpaper and give one or two thin coats of paint. Avoid the use of bright colors, and never use dark colors; a wood color or light drab is to be preferred. It is advisable to paint decks first, then give the hull its first coat just before launching.

Run your boat into the water until it is partially immersed but not water born and allow it to remain on the cradle until it is perfectly tight.

When leaking ceases, float off under the shears where the mast, which has already been rigged, can be stepped and wedged, rigging can now be set up, sails bent on, and you are ready for your summer's fun.

Should the craft continue to leak and you are convinced that it will not tighten up in the usual way, do not attempt to remedy the difficulty yourself, as in calking a small leak you are apt to create a larger one. If the seams are filled with soap before launching this can be scraped off as the planks come together, but if putty or lead are used in too great quantities, the surface will present a ribbed appearance, and occasion a great deal of hard work in removing it the next year.

Be sure that the hole in the garboard is plugged before launching; this oversight has caused many a tight craft to fill and sink in launching.

If iron is used for ballast, give it one or two coats of red lead before storing.

In rigging, whip all rope ends; nothing looks more slovenly aboard than "cows tails" on sheets or halliards.

For equipment, carry two good anchors and plenty of cable, also a good compass and charts; a coil of rope is also a necessary adjunct. Don't forget the lights, lead and fog horn. All of these are absolute necessities, and while many articles can be added to your inventory that will increase your comfort, they are largely a matter of taste and capacity of the pocketbook.

Crude Oil Fuel is being used in the boiler plant of the Eagle Flour Mills at Newton, Mass., at a cost comparing very favorably with that of coal. About 170 bbls. of oil are burned per week at a cost of from 3.99 to 4.69 cents per barrel of flour manufactured. The fuel cost when using coal averaged 4.6 cents per barrel of flour output, not taking account of the labor cost of handling the coal and stoking. The burner used is the Hammel crude oil burner, which uses steam for atomizing the liquid fuel, and no change was made in the furnace except to cover the grates tightly at the rear with bricks and sand, and at the front with half bricks laid loose with 1 in. air spaces; at the front close to the furnace doors an 8x12-in. air opening was left clear on either side. Combustion is absolutely smokeless when the burner is properly regulated.

A TWENTY FIVE FOOT AUXILIARY YAWL.

CARL H. CLARK.

VI. Cabin Fittings—Installing Engine.

A slide or hatch must now be fitted over the opening in the cabin roof. It is shown in detail in Fig. 27, and consists of two side pieces, with a groove about 1/2 in. square on the inside. The cover is built up on cross beams which have projections fitting into the groves in the side pieces. In this way the cover can slide forward and yet stay in place. Door jams and sill are next fitted. The sill should be raised about 6 in. above the standing room floor. Doors may be purchased quite cheaply, so that it will be better to do this than to attempt to make them.

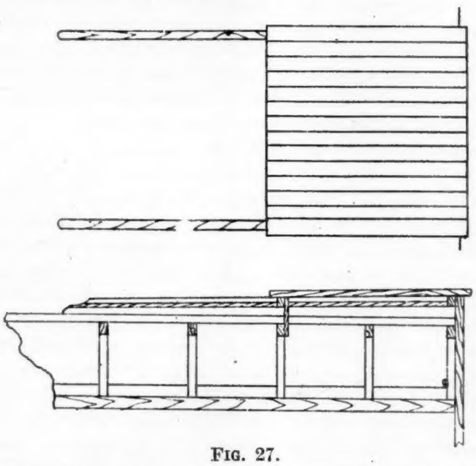


FIG. 27.

The inside of the cabin can be arranged to suit the individual ideas of the builder; as it is a rather simule mateer, but few directions will be given. A very convenient arrangement, however, is to have a transom, or berth, on each side about 10 in. above the floor and about 6 1/2 ft. long, adjusting the width so as to leave about 12 in. between it and the centerboard trunk. At the forward end of each transom a locker can be arranged for dishes, etc., and forward of this can be other lockers to suit the builder. Room should, however, be left for the storage of anchors and cables.

A folding table can be fitted to top of the centerboard trunk; and such other fittings as may be considered desirable.

The seats in the standing room are arranged to run all the way around except across the forward end. They should poject about 14 in. clear of the washboard, and are supported on stanchions and braces to the ribs.

If a tiller is fitted, it should project out above the seat and be curved upwards to be easily grasped. Some sailors prefer a wheel for steering; it is, howeer, a matter of fancy. If a wheel is fitted, a box is built above the seat to cover the gear. This work, with such additional small variations which may be worked in, should about complete the construction of the hull.

The installation of the engine is the next work on hand. The size may vary from 3 to 6 horse power, according to the amount the builder can afford to put into it. A 3-horse engine will make her easily controllable in calm weather and give a fair speed. A 6-horse power, on the other hand, will enable her to be ıun under the engine in any circumstances. If a single cylinder engine is selected, not over 3 1/2 h. p. should be used, on account of the weight. A double cylinder engine is by all means to be preferred, as it is lighter, smaller, and sits lower in the boat. An engine of this type of about 4 or 5 h. p. will be found to give excellent results. It should be of the medium weight, high speed type and be as light as possible.

The engine bed must be built from measurements taken from the engine. The bed is built as shown in Fig. 22, of two side pieces, resting either on the bottom or on heavy cross braces. The side pieces are of oak, about 2 1/2 in. thick and the same distance apart as the flanges of the engine. If the width outside of these side pieces is greater than the width of the bottom, three cross pieces can be fitted in across the bottom and the side pieces fitted on top of these, being notched down over them and nicely fitted. The upper edge of these side pieces must be in the same relation to the shaft center as the flanges on the bed. Between the side pieces, vertical cross pieces are fitted to hold the side pieces rigid. The whole is then firmly fastened together and to the bottom. A line or wire passed through the center of the shaft hole and drawn tight to a nail on the centerboard trunk will be of great help in locating the center.

When this is done the engine can be placed in position on the bed. The shaft and stuffing box should now be put into place, the stuffing box fitted nicely against the stern post, so that it will not bind the shaft when fastened in place. The under face of the stuffing box should be well smeared with lead before fastening. The propeller is now placed on the shaft and the latter inserted into the hole in the coupling on the engine. The exact amount to be cut off in order to bring the propeller to the proper position may then

be measured. When this is done, the shaft is reinserted and the coupling set screws tightened up. If the engine is correctly set all will now be free and turn easily. If they do not, the alignment of the engine can be changed slightly by twisting it, or by placing thin strips of wood under the flanges. When this is correct the engine may be fastened down with lag screws. The rudder and iron skeg may now be put in place.

The first piping to be fitted in place should be the exhaust. If a muffler is used it may be placed under one seat with the outlet through the side of the boat, or it may be placed in the stern under the overhang, with the outlet through the sternboard. In either case the piping should run below the standing room floor.

For the engine in this position an under-water exhaust is a very good device, as it saves considerable piping. Great care must, however, be used in fitting the under water exhaust as otherwise considerable back pressure may be caused, which reduces the power. This back pressure may be reduced by having the exhaust as near the water-line as possible. A pet cock should be placed in the exhaust pipe near the engine, by opening it when the engine is stopped the water cannot be drawn up into the cylinder by the vacuum.

There is a make of under-water exhaust which contains a passage through which the water is forced by the motion of the boat, mingling with the exhaust and drawing it out. It is said to give very good results. In many cases the exhaust may be arranged to pass out directly at the water-line. The method to be used will vary with the makes and style of engine used, so that more specific directions can hardly be given.

The cooling water may be piped next, using the same size pipe as the connections on the engine. The strainer for the inlet should be placed near the engine and yet for enough down on the bilge so not to be thrown out of water by the rolling of the boat. A short piece of rubber hose should be inserted on the line to give elasticity and prevent the vibration of the engine from starting the connection of the pipe with the hull and causing a leak. The discharge of the cooling water may either be carried out through the side well above water or into the exhaust. The latter is the preferable way.

The gasoline tank should hold about 10 gallons, and may be placed forward of the mast, or under the seats in the standing room. If the muffler is placed under one seat the tank may be placed opposite it to balance it. If the muffler is placed in the stern, or if no muffler is used, two gasoline tanks can be fitted, one under each seat, allowing them to me smaller, and so less conspicuous. The filling pipe should in any case run up through the deck outside the coaming, so that any overflow will drain overboard and not into the bilge. A stop cock should be fitted at the tank and also at the carburettor. The gasoline piping should be of 1/8 in. lead pipe, with all joints soldered.

Batteries and coils should be kept in the cabin where they will be dry, as moisture is detrimental to both.

After the engine is completely set up, the floor may be fitted around it. A portion around the engine should be easily removable, and a ledge about 1 1/2 in. high should be fitted around the edge of the opening.

If desired a box may be made to cover the engine when it is not in use; but as a box is a rather clumsey affair to stow when the engine is running, a cover of thick water proof canvas will do equally well and takes up less room.

There are many details both as to hull and engine fitting which can as well be left to the fancy of the builder. A little observation of existing boats will often give one many valuable points as to fitting and small details of equipment. It is advised that at about this stage of the work, the amateur builder take a few trips, if possible, among any boat shops or storage places which may be in his neighborhood.

With the finishing of the work as described the hull and engine should be about complete, leaving only the sails and rigging, which will be the subject of the next chapter.

The fact that a luminous emanation of variable shape will appear in the dark at such points on the surface of the earth below which there are extensive ore deposits at a more or less considerable depth was recorded in Germany as far back as 1747, says the "English Mechanic." Immediately before or during a thunder-storm these phenomena are said to be especially striking. Similar observations have more recently been made in North America in the neighbourhood of ore deposits. Though much should be ascribed to superstition and to errors of observation, the fact has nevertheless been confirmed by recent investigation. The electric emanation given off from the surafce of the earth has, in fact, been repeatedly ascertained photographically by Mr. K. Zenger. Plates coated with fluorescent substances were used. It may thus be taken for granted that the emanations in question occur with an especially high intensity at those points of the ground where good conductors of electricity are found in large amounts in the neighborhood of the surface of the earth; in other words, above ore deposits, which are very good conductors of the electric current. Lignite and coal, especially when containing pyrites, are fairly good conductors. The difference in the intensity of radiation as compared with points free from any ore would seem to be recognized by means of photography, thus affording to geologists a rather simple means of locating ore and even coal deposites.

USE OF ALCOHOL AND GASOLINE IN FARM ENGINES.

The United States Department of Agriculture has published in Farmers' Bulletin, No. 277, a very complete report, entitled "The Use of Acohol and Gasolene in Farm Engines," by Charles Edward Lucke, assistant professor of mechanical engineering, Columbia University, New York, and S. M. Woodward, irrigation engineer, office of experiment stations, Washington, D. C.

The following abstracts are of general interest:

The newest fuel for power purposes is alcohol. This is made from the yearly crop of plants. There is in existence no natural deposit of alcohol, but in a sense it may be said to be possible to produce inexhaustible supplies.

It is only within recent time that engineers have known how to build engines that would produce power from alcohol; and still more recent is the further discovery by engineers that this power can be produced at a cost which may permit its general introduction.

The cost of fuel per unit of power developed depends first, on the market where it is to be used, and next, but by no means least, on the ability of the machinery to transform the fuel energy into useful work. If all the different kinds of machinery used for power generation could turn into useful work the same proportion of the energy in the fuel, coal would be almost universally used, because of the present low cost of energy in this form.

Anthracite coal in the neighborhood of New York can be bought in small sizes in large quantities for power purposes at about $2.50 per ton. This coal will contain about 12,500 B. T. U. per pound. This is equivalent to about 10,000,000 heat units per dollar. Large sizes, such as egg coal, containing about 14,000 B. T. U. per pound, can be bought in large quantities for about $6.25 per ton, which is equivalent to 4,500,000 B. T. U. per dollar. Other grades of anthracite coal and the various grades and qualities of bituminous coal will lie beween these two limits of cost. Illuminating gas in New York costs $1 per 1,000 cubic feet, which is equivalent to about 500,000 heat units per dollar. Natural gas in the Middle States is sold for 10 cents per 1,000 cubic feet and upward. This fuel at the minimum price will furnish about 10,000,000 heat units for a dollar. Crude oil sells in the East at a minimum price of four cents per gallon, which is equivalent to about 4,000,000 heat units per dollar. Gasolene sells at a minimum price of ten cents per gallon, which is equivalent to about 1,200,000 heat units per dollar. Kerosene sells from ten to thirty cents per gallon, which is equivalent to 1,200,000 and 400,000 heat units per dollar, respectively. Grain alcohol, such as will be freed from tax under the recent legislation, will sell for an unknown price; but for the purpose of comparison, assuming thirty cents per gallon as a minimum, it will give 270,000 heat units per dollar. Gasolene, kerosene, crude oils, and, in fact, all of the distillates have about the same amount of heat per pound; therefore, at the same price per gallon, ignoring the slight difference in density they would deliver to the consumer about the same amount of heat per dollar, whereas the other liquid fuel, alcohol, if sold at an equal price, would give the consumer only about three-fifths the amount of heat for the same money. From the figures above given it apears that the cost of heat energy contained in the above fuels, at the fair market prices given, varies widely, lying between 200,000 heat units per dollar and 10,000,000 heat units per dollar. It is possible to buy eight times as much energy for a given amount of money in the form of cheap coal as in the form of low-priced gasolene, or twenty-five times as much as in the form of high-priced gasolene or kerosene. This being true, it might seem to a casual observer as rather strange that gasolene should be used at all, and the fact that it is used in competition with fuel of one-eighth to one-twenty-fifth its cost shows clearly that either the gasolene engine has some characteristics not possessed by an engine or plant using coal, which makes it able to do things the other can not do, or that more of the heat it contains can be transformed into energy for useful work. Both of these things are true.

Large steam plants in their daily work seldom use less than two pounds of poor coal per hour for each useful horse-power (known as a brake horse-power), which is equivalent to about 25,000 B. T. U. per hour, and which corresponds to about ten per cent thermal efficiency. Small steam plants working intermittently, such as hoisting engines, may use as high as seven pounds of coal per brake horse-power, or 2.5 per cent. thermal efficiency. Some plants will do better than the above with proper conditions, and some may do worse, but in general it may be said that the performances of steam plants lie between the limits of 2.5 and 10 per cent. thermal efficiency.

Plants consisting of gas-producers for transforming coal into gas for use in gass engines have in general a much higher thermal efficiency than steam plants doing the same work. They are, however, not built quite so small as steam plants, the smallest being about twenty-five horse power, and in general they have not been built so large, the largest being only a few thousand horse-power. Their efficiency, however, does not vary so much as is the case with steam plants. It may be fair to say that under the same conditions as above outlined these plants will use one and one-quarter to two pounds of coal of fair or poor quality per brake horse-power hour, which gives a thermal efficiency ranging from eighteen to ten per cent. These plants can be

made to do much better than this, and perhaps may do worse, although the variation is not nearly so great as for steam plants.

Gas engines operating on natural gas or on illuminating gas from city mains will, on fluctuation of load with the regular work, average about 12,000 heat units per brake horse-power, or 20 per cent. thermal efficiency. Exploding engines operating on crude oil will average about 25,000 heat units per brake horse-power hour, which is equivalent to about 10 per cent. thermal efficiency. Exploding engines using gasolene should operate at a thermal efficiency of about 19 per cent. under similar operating conditions.

The efficiency of an alcohol engine may be assumed at this time to be unknown, but as alcohol can be burned in engines designed for gasolene, it may be assumed that such an engine will have with alcohol fuel the same thermal efficiency as with gasolene, 19 per cent. for fair working conditions.

From the above brief discussion of the efficiency of different methods of power generation from different fuels it appears that quite a range is possible, though not so great a range as exists in the case of cost of fuel energy. Efficiency is seen to lie somewhere between 2 1/2 and 20 per cent for all the fuels under working conditions. It is known that actual thermal efficiency under bad conditions may be less than 1 per cent. and under the best conditions as high as 40 per cent, but these are rare and unusual cases. The range given is sufficient to indicate that a highly efficient method may make the fuel cost per unit of power less with quite expensive fuel than it would be with cheaper fuel usel in a less efficient machine. It is also perfectly clear that without proper information on the efficiency of the machine or the efficiency of the plant it is impossible to tell what the cost of fuel per horse-power will be, even though the price of the fuel per ton or per gallon be known.

The following conclusions regarding the use of alcohol as fuel for engines as compared with gasolene are based on the preliminary results of the department's experiments, upon results of the European experiments and investigations which have been presented in the foregoing pages, and upon the general knowledge of the author:

(1) Any engine on the American market to-day, operating with gasolene or kerosene, can operate with alcohol fuel without any structural change whatever with proper manipulation.

(2) Alcohol contains approximately 0.6 of the heating value of gasolene, by weight, and in the department's experiments a small engine required 1.8 times as much alcohol as gasolene per horse-power hour. This corresponds very closely with the relatve heating value of the fuels, indicating practically the same thermal efficiency with the two when vaporization is complete.

(3) In some cases carburetors designed for gasolene do not vaporize all the alcohol suplied, and in such cases the excess of alcohol consumed is greater than indicated above.

(4) The absolute excess of alcohol consumed over gasolene or kerosene will be reduced by such changes as will increase the thermal efficiency of the engine.

(5) The thermal efficiency of these engines can be improved when they are to be operated by alcohol, first by altering the construction of the carbureter to accomplish complete vaporization, and second, by increasing the compression very materially.

(6) An engine designed for gasolene or kerosene can, without any material alterations to adapt it to alcohol, give slightly more power (about ten per cent.) than when operated with gasolene or kerosene, but this increase is at the expense of greater consumption of fuel. By alterations designed to adapt the engine to new fuel this excess of power may be increased to about twenty per cent.

(7) Because of the increased output without corresponding increase in size, alcohol engines should sell for less per horse-power than gasolene or kerosene engines of the same class.

(8) The different designs of gasolene or kerosene engines are not equally well adapted to the burning of alcohol, though all may burn it with a fair degree of success.

(9) Storage of alcohol and its use in engines is much less dangerous than that of gasolene, as well as being decidedly more pleasant.

(10 The exhaust from an alcohol engines is less likely to be offensive than the exhaust from a gasolene or kerosene engine, although there will be some odor due to lubricating oil and imperfect combustion, if the engine is not skilfully operated.

(11) It requires no more skill to operate an alcohol engine than one intended for gasolene or kerosene.

(12) There is no reason to suppose that the cost or repairs and lubrication will be any greater for an alcohol engine than for one built for gasolene or kerosene.

(13) There seems to be no tendency for the interior of an alcohol engine to become sooty, as is the case with gasolene and kerosene.

(14) With proper manipulation, there seems to be no undue corrosion of the interior due to the use of alcohol.

(15) The fact that the exhaust from the alcohol engine is not as hot as that from gasolene and kerosene engines seems to indicate that there will be less danger from fire, less offense in a rom traversed by the exhaust pipe, and less possibility of burning the lubricating oil. This later point is also borne out by the fact that the exhaust shows less smokiness.

(16) In localities where there is a supply of cheap raw material for the manufacture of denatured alcohol, and which are at the same time remote from the

source of supply of gasolene, alcohol may immediately compete with gasolene as a fuel for engines.

(17) If, as time goes on, kerosene and its distillates become scarcer and dearer by reason of exhaustion of natural deposits, the alcohol engine will become a stronger and stronger competitor, with a possibility that in time it may entirely suplant the kerosene and gasolene engines.

(18) By reason of its greater safety and its adaptability to the work, alcohol should immediately supplant gasolene for use in boats.

(19) By reason of cleanliness in handling the fuel, increased safety in fuel storage, and less offensiveness in the exhaust, alcohol engines will, in part, displace gasolene engines for automobile work, but only when cost of fuel for operation is a subordinate consideration. In this field it is impossible to conveniently increase the compression because of starting difficulties, so that the efficiency can not be improved as conveniently as in other types of engines.

(20) In most localities it is unlikely that alcohol power will be cheaper or as cheap as gasolene power for some time to come.

AREA OF THE UNITED STATES.

The question, "What coinstitutes the area of the United States?" would seem to the ordinary layman a simple one; but according to Bulletin 302 of theUnited States Geologial Survey, of which Henry Gannett is the author, it is quite the reverse. Jurisdiction extends to a line 3 nautical miles from the shore, but this strip of sea cannot properly be regarded as a part of the country. Supposing our country to be restricted to the sea and lake coast, there remains a question regarding the bays and estuaries. To what extent should the coast line be followed strictly, and where should we begin to jump across the indentations made by the sea? In this matter one can only follow his own judgment, making in each case as natural a decision as possible, as no definite criterion can be established.

The measurements and computations upon which these tables were based were made with great care and thoroughness in each case, and the results probably represented the areas as closely as they could be determined from the maps and charts in existence at both times. Most of the differences in these two sets of tables are trifling, amounting to only a few square miles or a small fraction of 1 per cent, being well within the limits of error of the planimeter and of the maps used. Some of them, however, are considerable, and a few are explained by the fact that more recent maps, which changed the position of boundaries between states, had been used by the Land Office, and its measurement was, therefore, more nearly correct. Other discrepancies arose from differences in determining the coast lines.

Realizing the desirability of but one government statement of areas of the states and terrotories, an attempt has been made by Frank Bond, chief draftsman of the General Land Office; C. S. Sloane, geographer of the Census Office, and Henry Gannett, geographer of the Geological Survey, to come to an agreement on these figures. The results of their conference and co-operation are set forth in the aforementioned bulletin.

By this adjustment the area of the United State proper, which is given as 3,026,789 square miles, is increased over the Census Office figures by 1,188 square miles.

The area given for Alaska is 590,884 square miles. It is subject to considerable modification in the future as the position of the coast line becomes better known. The area given for the Philippine islands is 115,026 square miles, and was determined by the Coast Survey of that archipelago, prepared at the instance of the Philippine Census. It also is subject to modification as accurate charts of the archipelago are made. The areas of Hawaii, 6,449 sqpuare miles, and Porto Rico, 3,435 square miles, are probably subject to only slight changes, as the charts from which they were measured are quite accurate. The areas given for the other small possessions of the United States, Gaum, 210 square miles; Samoa, 77 square miles, and the Panama canal strip, 474 square miles, will probably be changed in the future as their limits become more correctly defined.

Given two young men of equal ability, and let both of them go through good technical schools, both graduating as chemists, or as mining, mechanical, civil or electrical engineers. The one during the course of his study has covered much ground, has stored his mind with facts, has learned carefully and well the methods and manipulation required in the branch chosen. The other has not covered so much ground, but every bit of information that he has he thoroughly understands; he has acquired principles rather than a large array of facts, and he knows the reasons why. Let now these two begin work after graduation in the same place, and we are ready to confess that the former will make the best showing, and progress the more rapidly for the first year or two, but if our observation is worth anything, the latter will distance his competitor at the end of ten years.—Dr. Chas. B. Dudley.

The transporting power of a current of water, or the weight of the largest fragment it can carry, varies as the sixth power of the velocity. That is, if a current of certain velocity will move a cubic inch of stone, when the velocity of the current is doubled, it will move a stone sixty-four times as large, and if the velocity were increased ten times, the transferring power would be increased 1,000,000 times.

AMATEUR WORK.

DRAPER PUBLISHING CO., Publishers,

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A Monthly Magazine of the Useful Arts and Sciences. Published on the first of each month for the benefit and instruction of the amateur worker.

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Single copies of back numbers, 10 cents each.

TO ADVERTISERS.

New advertisements or changes, intended for a particular issue, must be received at this office on or before the 10th. of the previous month.

Entered at the Post Office, Boston, as second class mail matter, Jan. 14, 1902.

APRIL, 1907.

Owing to a serious accident this issue is much delayed. We are making a big hustle and expect to issue the May number about on time.

The patterns for the 75-watt and 150-watt dynamos recently described in this magazine has been completed and premium offers of castings for same will be made in the May number.

We very much desire to know how many readers are interested in photography, and would request those who are to send us postal communications stating this and what additions to this department they would like.

Through an error an extra large supply of volume V have been bound. To quickly move a portion of this stock we will send a copy, postpaid for $1.00. This offer is limited to 2oo copies, the first orders received up to this number to be filled.

For the information of readers interested in gas engines, we announce the publication in the May issue of a description of a 3 1-2 x 3 1-2 in. vertical two-cycle gas engine, this design being fully up-to-date in every particular. As soon as they can be prepared, castings will be offered as premiums and for sale, in both the rough and partly machined, thus enabling any one to finish an engine at small cost, and requiring but few tools for the work. The design is one which will also permit two cylinders being placed on one base, and also run as a two or three port engine as may be desired. If there should be a sufficient demand, castings will be gotten out for a 5x5 engine of the same design.

The first chapter of a very complete series of articles describing a model electric railway will be published in the June issue. The signals will be of the block signal type, and will be faithful representations of those in use on the railways about the country. Bridges, turntables, and other fixtures will be included in the several chapters, and arrangements are now being made to supply the parts ordinarily found difficult to obtain.

Sodium Transmission Lines.—The use of sodium for overhead transmission is attracting the attention of electricians. It is said to be cheap and a good conductor of electricity, but as its marked affinity with oxygen causes it to ignite when placed in contact with water, its employment in the form of a conductor would be limited, probably, to overhead transmission lines or feeders for railway work. The general process for constructing sodium conductors is to take standard wrought-iron pipes and heat them to a point well above the melting temperature of sodium. The sodium is then melted in special kettles and is run into the pipes, solidifying when cool. There is said to be no marked depreciation of either the sodium or the pipe if the latter be properly protected by a coat of weather-proof paint. For the same conductivity the price of the complete sodium conductor is much below that of copper cables, being in small sizes not more than 50 per cent. and in large sizes not more than 20 per cent. of the cost of copper. For instance, a half-inch wrought-iron pipe filled with sodium has a capacity of 19 amperes, and costs about 3 1/2 c. per ft., against 8 1/2 c. for a copper line of the same capacity. A 6-in. sodium conductor would carry 8,130 amperes, the cost of the line being about $1.40 per linear foot, as compared with $6.30 per foot for copper. These figures were estimated on the basis of 7 1/2 c. per lb, for sodium and 16c. per lb. for copper.

A piece of metal is not a homogeneous single thing. It is a collection of grains and granules that built it up just as the granules built up a glacier. The grains of metal are irregular in shape and unequal in size. Their existence is revealed by polishing and etching the surface of the metal and examining it under a microscope, when the grains can be readily distinguished by differences of texture and the boundaries between them can be clearly traced. Investigation shows that each grain is, in fact, a separate crystal, and the irregular boundaries are due to casual inequalities in the rates at which the various crystals have grown during their formation.

Detonators for exploding dynamite consist ordinarily of a mixture of mercury fulminate, and potassium nitrate or chlorate, placed in a copper capsule; when the cap is to be fird with a fuse, the fulminate is covered with shellac, collodion, thin copper foil, or paper, and the end of the capsule is left open ta receive the end of the fuse.

CONSTRUCTION AND MANAGEMENT OF GASOLINE ENGINES.

CARL H. CLARK.

XI. Installiing Engines—Under Water Exhaust.

The first question in the installation of the engine will be the bed, or foundation. Fig. 74 shows one of the most approved methods of construction, the bed. The two side pieces B, upon which the flanges of the engine bed rest, in turn rest upon the cross pieces A. These cross pieces A are built into the boat and distribute the strain. The side pieces B are notched down over the cross floors A and through fastened. A center piece C is worked in between the side pieces A whenever convenient to prevent their rocking sidewise. The whole is then firmly secured together and to the hull.

Small engines may be supported upon a single cross piece at each end of the bed, but except for the smallest sizes the arrangement of Fig. 74 should be used. The engine is fastened down to the bed with lag screws.

The particular function of the muffler is to afford a comparatively large space into which the exhaust may pass and expand, greatly reducing the pressure. The gas, under the reduced pressure, then passes out with little disturbance. The muffler need be of no particular shape, as long as the volume is sufficient. Mufflers are usually made of cast iron in the smaller sizes and of sheet iron in the larger sizes. In many cases a long piece of rather large pipe will answer the same purpose.

The muffler may be dispensed with and much space saved by carrying the exhaust directly through the bottom of the boat and exhausting under water. Although this is a very convenient and many times satisfactory way of doing it, great care must be used or poor results will be obtained. When the exhaust leads directly out, a certain amount of pressure is used in displacing the water. This pressure is, of course, sup-

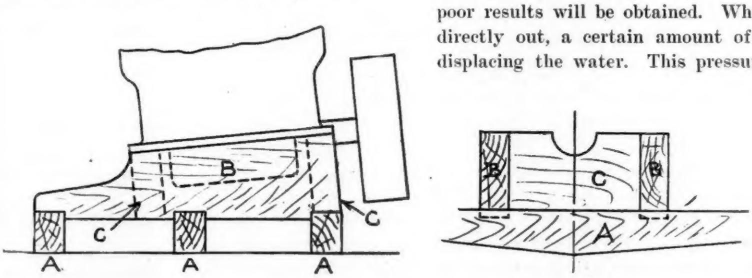


Fig. 74.

The heaviest, and in most cases the hardest, pipe to fit up is the exhaust pipe. It runs from the exhaust nozzle on the engine to the muffler and thence outboard. Fig. 75 shows a diagram of the piping as usually arranged. The muffler M is commonly placed in the stern with the outlet directly outboard It may, however, be placed in any convenient position as under the seats in the standing room, and the piping lead outboard. In any case, the piping for the exhaust should be as direct and as free from sharp bends as possible.

When the motor is near the middle of the boat, a good practice is to lead the exhaust pipe out through the bottom, along the bottom to a point near the stern, where it again enters the boat and connects with the muffler. The outlet from the muffler then leads directly outboard as before. This method, especially on a large cabin boat, avoids much loss of space and the disagreeable heat of the exhaust pipe. The surrounding water quickly cools the exhaust, reduces the pressure, and makes the exhaust almost noisless.

plied by the piston and is a back pressure, as it is turned, retarding the piston and decreasing its power.

A small expansion chamber or muffler should be provided between the engine and the outlet in order to break up the violent pulsations and make the flow fairly constant. Some form of shield should be fitted over the outer end of the exhaust pipe to guide the stream of the exhaust aft and prevent the water being forced into it by the movement of the boat. Several forms of these are on the market in the form of a brass casting which bolts on to the outside of the hull and has a thread on the inside to take the exhaust pipe.

One of the best of those is on the principle shown in Fig. 76. The exhaust passes from the engine to e and out at E, the passage being curved in an easy bend. At a is a funnel shaped passage opening into the exhaust passage. The motion of the boat is assumed to be toward the right; the water will be forced into the opening a and out through its small end, at a considerable velocity, mingling with the stream of

exhaust gases and tending to accelerate their flow. This principle tends to lessen the back pressure on the engine, and may, under some circumstances, entirely do away with it.

The under water exhaust is a very neat and simple method when corrently installed, as all noise and heat from the exhaust pipe are aoided. The exhaust may be considerably cooled and the noise reduced by discharging the cooling water from the cylinders directly into the exhaust pipe as shown in Fig. 75 and explained more in detail later. All sharp bends must be avoided in the exhaust pipe as the resistance offered by them is equivelent to back pressure and reduces the power of the engine.

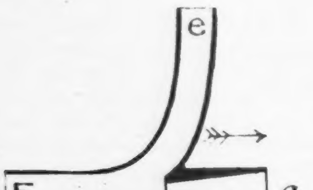


FIG. 76.

When the exhaust pipe is run under the floor a pet cock should be fitted at its lowest point, to drain off any condensation or collection of moisture. The discharge from the muffler should pass out through the side of the boat well above the water line, so that there will be little chance of its becoming submerged and flooding the muffler. When the engine is working there will, of course, be no chance for the water to pass in against the exhaust pressure, but if the boat were moored there might be a possibility of such an occurrence.

When the under water exhaust is fitted, a pet cock should be put in the exhaust pipe near the engine. This is opened when the engine is stopped, thus preventing the water from being drawn up into the cylinders by the vacuum caused by the cooling of the gasses in the pipe and cylinders.

The water piping of brass pipe is next to be fitted. The connection to the suction S of the pump P should be piped down through the bottom of the boat at some convenient point. This pipe may be made up solid,

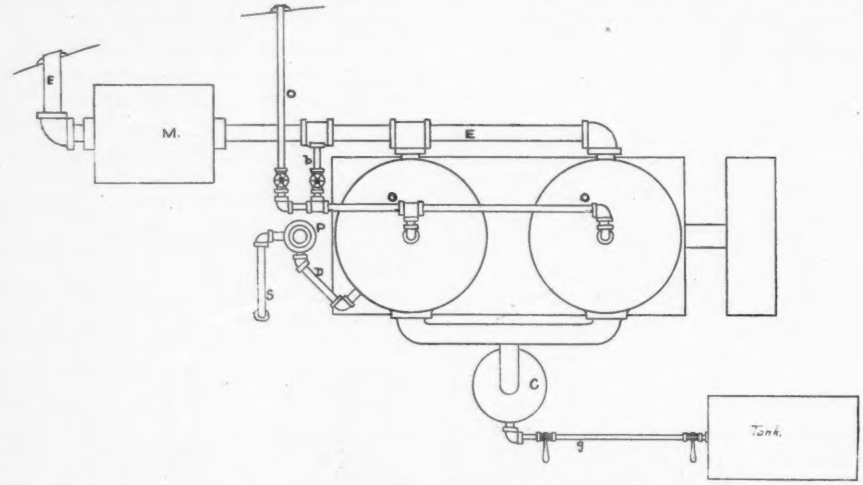


FIG. 75.

although many people fit a short length of rubber hose at a convenient point to take up the vibration of the engine and prevent the starting of the joints where the pipe passes through the hull. The outer end of this pipe is covered with some kind of strainer to filter out weeds, etc. A special casting is usually furnished including a clamp for both inside and outside of planking and a thread for the end of the connecting pipe. Care must be taken where this pipe passes through the planking, to get a good joint or leakage will ensue. In small engines the entire water piping may conveniently be of rubber hose. It is advisable to fit a valve on the pipe just inside the hull, by closing which, all possiblity of flooding the boat will be avoided.

If desired, a double suction may be fitteed to the pump, one branch leading as above and the other leading to the bilge inside. A valve in each branch will allow either to be used as desired. In this way the pump may be used to pump out the boat. As all of this water passes through the cylinder jackets this use of the pump is questioned by many. If, however, the bilges of the boat are kept fairly clean and the pump is used for this purpose only at the beginning of a run the effects cannot be very bad.

The connection from the pump discharge d to the cylinders should be found already piped; in fact, on

small engines the pump is attached directly to the cylinder. The outlet O from the cylinders may either lead directly overboard through the side of the boat above water, or have a branch b leading into the exhaust pipe. In the latter case a valve should be fitted in each pipe so that the water may flow either overboard or into the exhaust, or both of these ways. The cooling water should not be put into the exhaust until the latter has become heated, and should be taken out from the exhaust a short time before the completion of the run, so that the moisture may all evaporate, leaving the pipe dry.

The piping g for the gasoline supply requires the greatest care as any leak may have fatal consequences. Too much stress cannot be laid on this point as nearly all accidents can be traced to this cause, combined with more or less carelessness. The gasoline tank should be of solid construction of either copper or galvanized iron. It should be well riveted and soldered, and thoroughly tested. The filling pipe should extend from the tank to above the deck, so that any overflow while filling the tank will run overboard instead of into the bottom of the boat.

Many people indorse the fitting of pans or other arrangements to catch and carry off any leakage, but it is, in the writer's opinion, best to make sure that all joints are absolutely tight, and assure that they stay so by occasional observation. The piping for the gasoline should be of either copper, brass or lead with as few joints as possible and those, except a union at end, soldered. A stopcock should be soldered to the tank and another fitted to the carburettor.

Some form of strainer had best be fitted in the gasoline pipe near the carburettor. Fig. 76 shows a good form of device for this purpose. It consists of a chamber containing a screen of wire gauze, through which the gasoline must pass. The bottom can be unscrewed and any collection removed. A device like this will remove any sediment or water which may be contained in the gasoline. If it is not possible or desirable to buy one, it is possible to make one out of pipe fittings which will answer the purpose. A fitting of this kind is likely to save a great deal of bother some time. The caution should again be repeated, to have all gasoline connections absolutely tight.

The gasoline tank may usually be placed wherever is most convenient. The most common place is perhaps in the bow, as the space there is of comparatively little value. When the engine is near amidships and a water tight standing room is fitted, a very good position is under the standing-room seats. Any possible leakage would then drain overboard. The tank should, of course, be kept as far away as possible from hot exhause pipe or muffler.

This completes the usual piping, and any additional piping would be simply an extension of the piping just described.

The batteries, coils and wiring should be kept in a dry place, as any moisture greatly interferes with their action or may even ruin them completely. If a magneto is us used it may be fastened to the floor or to a frame on the engine. The latter method is preferable when possible, as there is less likelihood of damage.

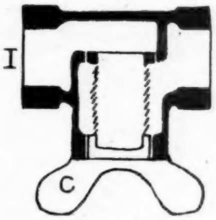


FIG. 77.

All wiring should be of the best grade of wire, and joints and connections should be carefully wound, or best, soldered, and taped. In the case of a jump spark engine the coil or coils should be placed as near the engine as is convenient, to reduce as much as possible, the length of the secondary wiring.

It is often advised to seal up the batteries in a tight box, or even bury them completely in tar or other material, with the object of keeping the moisture away from them. These methods are, however, hardly to be advised, as a single poor cell will spoil the action of a whole set, and it is better to have the cells accessible, so that in case of trouble they can be tested and the poor ones replaced. Two sets of batteries should always be used for general running with an occasional rest, and the other set retained in their full strength for starting or for emergencies.

In all the piping and wiring a great effort should be made to keep everything as simple and direct as possible, so that in the case of trouble or repairs, all parts may be quickly and easily gotten at.

It is also important that a convenient tool and supply locker should be provided. It is too often the case that small tools or parts which should be on hand are missing, causing much delay and inconvenience. This locker should be handy of access, and should be of such construction as to prevent the access of water to the tools, which quickly renders them useless. This is a point to which too little attention is usually given.

It is, of course, impossible to enumerate all of the small details of the work of instalation, but with the principles of the above in mind, no difficulty should be found in following out the work of almost any ordinary installation.

One of the causes of loss in the transmission of compressed air is pumping the air of the engine room rather than that drawn from a cooler place. The loss amounts to from 2 to 10 per cent.

BEST EDUCATION FOR MECHANICS.

The question as to the advisability of young men and boys in manufacturing establishments, such as that of the Crane Co., spending their time and money in taking up studies in technical schools, is one on which the president of this company had intended expressing his views at some future period; but as a number of Crane Co. employees have made a request for his advice on this subject, he has decided to publish his views now.

It seems to be a popular belief that technical education is indispensible in the production of good mechanics, foremen, etc., and I wish to say most emphatically that I do not agree with this theory in the slightest degree. I never received such education myself, nor have I ever had such men about me in my shops with the exception of a few in the drafting-room, and even in that case there is no advantage except in the carrying out of orders and in making drawings.

So far as manufacturing is concerned, I am most decidedly of the opinion that time spent in technical schools trying to produce mechanics is absolutely wasted. I maintain that what is necessary for men to have in order to be successful in manufacturing is a thorough knowledge of the art, and of the kind of machines best adapted for certain purposes, and how much the machines are capable of producing.

In addition to this, probably the most valuable qualification in such a man is tact in the handling and selecting of his men, and in this feature of the work kindness, consideration, appreciation, and fair treatment are the great essentials. He should also have a large amount of enthusiasm and activity in covering the ground thoroughly, and should know that all machines and men are turning out a day's work, that no unnecessary waste is allowed, and that the quality of the goods is strictly maintained.

I have never been able to see where technical education cuts the slightest figure in any of these things; but, on the contrary, I am quite strongly of the opinion that technical education is a positive drawback in such a business as ours.

The great trouble with technical schools appears to be that they make a boy feel that he is getting a knowledge of things there which are essential to his success, and that he is, therefore, superior to the boy who is brought up in the shop; and if he goes into a shop, he does so with his head swelled to such an extent that he is unable to grasp the sound practical things that are essential to success. If he is to succeed, he practically has to be knocked around until all those false notions are got rid of before he can begin to learn things that are of real material value.

The boy who is going to make progress in his mechanical education must be thoroughly wide-awake while working in the shop, to observe all the mechanical features by which he is surrounded and get a thorough understanding of them, studying over them and spending all his leisure time in seeking more information. In that way he can acquire a fund of knowledge which, if he advances into a higher position, will be valuable to him; but if he does not show any interest or energy in this direction, he, of course, will turn out to be but little different from the machine on which he has been working.

In my opinion, all that our workers need in the way of schooling is the following:

Drawing.—It is a good idea for them to know enough about drawing to be able to read drawings and make a reasonably good drawing.

Arithmetic.—They should have a reasonable knowledge of common arithmetic, and be able to do ordinary work in arithmetic correctly.

English.—They should have a reasonably good understanding of English.

Writing.—They should be able to write a plain hand.

Men or boys who are deficient in any of these respects may acquire such knowledge at the public night schools.

The solving of difficult problems by such methods as the differential calculus, etc., may be a very interesting and entertaining pastime, but as far as serving and other purpose is concerned, it is simply a waste of time to the general workman, for in a factory there are no problems of this nature that need to be worked out.

It is the exercise of pactical, sound common sense that makes manufacturing today a success.

Many people are deceived in regard to this matter of technical education by the fact that some of the graduates from these schools get into good positions. There is no doubt that this is true, but only to a very limited extent, and I maintain that where one of these boys obtains a good position, a dozen young men who have not had this education also get into good positions, and fill them equally as or better than the technically educated man. It seems to me that this is conclusive evidence that there is no special advantage in this education, and I very much doubt if any of such technically educated young men can be found in factories that have to meet with red-hot competition in business. I have heard of concerns that tried many of these boys and had to throw them all out.

Some years ago a man spoke to me about a relative or friend of his who had been through one of these schools, and, upon leaving, obtained a good position in a machine shop, where he was doing well, and he regarded this as quite a triumph for that class of schools.

In reply to this, I said to him that in my estimation if the same young man had gone into the shop in which he was then working, at the time he started in the school, he would have become very much more of a success, and, to my mind, there is not the slightest doubt as to the correctness of this position. In other words, I regard practically all of these schools as being gigantic humbugs.

I wish it to be clearly understood that in condemning technical education I have reference simply to such education in connection with the making of general mechanics. My criticism is not intended to apply to such lines as electricity, mining engineering, chemistry, etc.

A great deal has been said about the value of these technical schools in Germany, but notwithstanding all such statements as to the wonderful results that have been accomplished there by reason of this education, I maintain that these schools are a humbug in that country just as they are here; furthermore, that we have made decidedly greater advancement in a mechanical way than Germany, and that I have never heard of any firm in the United States seeking for help among the Germans who have attended the technical schools over three, for which so much is claimed.

In evidence that the contrary is the case, I would mention that a member of my family, when visiting a large electrical manufacturing concern in Nuremberg, Germany, found not only that it was full of American machinery, but that it was being run by Americans, which strikes me as rather a knockout for the great claims that are made in regard to the advancement of the Germans in work of this nature.—Valve World.

HISTORY OF THE GAS ENGINE.

Like almost all great inventions the gas engine is the product of many minds. It didn't suddenly happen, but has been gradually improved. In fact the modern motor is similar in many respects to some of the oldest types. It is an interesting fact that some of the engines made as far back as 1835 failed only because of the imperfect developments of some of the smaller details rather than the adoption of incorrect methods.

The exact date of the first gas motor is not definitely known. It is credited to Huyghens as far back as 1680. Huyghens proposed to use the explosive force of gunpowder as power. These experiments of Huyghens were without practical results. Papin in 1690 continued along this line; he proposed to explode a certain amount of powder in a closed cylinder. The explosion forced the air out of check valves, leaving in the cylinder a partial vacuum, that is, a pressure less than atmospheric.

The atmospheric pressure of the piston acted during the down stroke. The objections to this method were many. A pressure of 15 pounds was the maximum that could be reached. This necessitated a large and cumbersome cylinder. Secondly, it was impossible to produce in the working cylinder a perfect vacuum, hence the actual force available in doing work was the difference in pressure between 15 pounds and the partial vacuum in the cylinder. These objections were so great that the experiments of Papin were useless, as far as any real influence on the modern engine is concerned.

W. L. Wright in 1833 made a fairly practicable engine. It was double acting, that is, received an impulse per half revolution. The operation was similar to the steam engine. The mixture of air and gas was forced by separate jumps into the working cylinder, during only part of the power stroke. The charge was ignited by an open flame. This is the first engine on record where complete working drawings were made, though it is doubtful that the engine ever was actually made.

Up to 1837 no attempt was made to produce an engine of the compression type. William Barnet in 1835 describes an engine which comprest the charge prior to the firing. Here also the charge of gases was fired while the engine was crossing dead center, hence the force of explosion was utilized during the entire power stroke. This motor was not similar to the present gas engine, as the charge of gas and air was separately comprest, discharged into the working cylinder under pressure and ignited.

About this time the advantages of previous compression became prevalent. Lenoir in 1860 used an engine of the compression type, but he did not have a clear understanding of the nature of gaseous explosions. The supdden rise of pressure upon explosion and also almost equal drop, he tried to prevent by injecting steam to reduce, as he supposed, the too sudden pressure due to explosion and transform it into a more gradual impulse.

In 1867 Otto brought out a practical free piston engine and in 1876 he produced an engine of the compression type. This had the greatest efficiency of any engine yet made and had a sale of about 16,000.

tto produced an engine better than he knew, as he attributed the economy of his ignition to a slow ignition of the gases, whereas the real cause of efficiency was due to the compression used.

Up to 1885, the engines marketed were of the low speed type. The causes were several, but Daimler in his inventions struck at the root of the difficulty by using liquid fuel, introducing the now universally used poppet valves, and hot tube ignition is now supplanted by electric ignition. The increase of motor speed permitted much smaller designs for equal power.

Modern engines are built along the lines originally thought out by Daimler.—The Engineer.

In the middle ages the monks devoted themselves to alchemy, but, after failing repeatedly, were prohibited by the Pope from studying the art.

ELEMENTS OF DYNAMO DESIGN.

IRA M. CUSHING.

IV. Transforming Alternations to give Direct Current in Circuit.

The next step should be a consideration of the alternating E. M. F. impressed on circuit F from the rings and brushes, R and T in Fig. 10. A little though would clearly show that the rate of change of the lines going through the coil W vary much during a half revolution. With the coil at right angles to the lines of force, as shown in the figure, a turn of a number of degrees makes but the slightest change in the lines threading through the coil. The E. M. F. is, therefore, at zero, with the coil at 90 degrees to the lines, but begins building up as the coil progresses in the turn until it reaches the maximum when the coil is parallel to the lines of force, for at that point the rate of change is the greatest. As the coil continues its revolutions, the E. M. F. dies down again to zero, which is at the time the coil reaches the 180 degree mark. As the coil completes its turn the rise and fall of the E. M. F. is repeated, but in the opposite or negative direction.

The action can best be shown by diagrams. Let the line A-B, Fig. 12, represent zero potential. On this line are shown the degrees which the coil passes through in a complete turn; namely 360. Vertical lines, erected from the base line indicate the values of the E. M. F. found at each degree, those above the base line being considered as positive and those below as negative. Through the points thus obtained draw a smooth curve, and the result will be the curve A C D E F. This shows, graphically, that the voltage is zero at 0, 180 and 360 degrees and maximum at 90 and 270 degrees. Since the coil has completed a revolution and is ready to start on another at the 360th degree, it can be readily seen that the curve repeats itself every 360 electrical degrees.

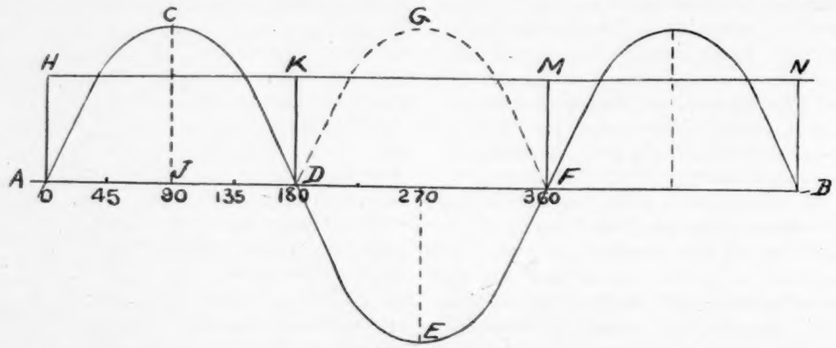


FIG. 12.

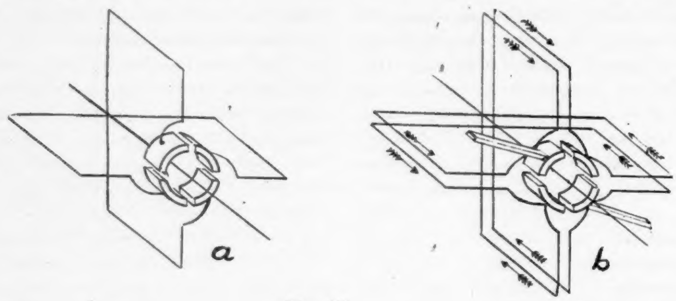


FIG. 13.

In the cycle described A C D is an alternator, and since D. E. F. is a duplicate of A C D, is except for the sign, it is seen that there are two alternations per cycle. The term electrical degrees is used because if the dynamo has more than two poles this cycle is repeated two or more times during a revolution; in fact, it is repeated as many times as there

are pairs of poles, or in other words there are as many times 360 electrical degrees in an armature as there are pairs of poles.

As stated before, the object of the commutator was to reverse the E. M. F. delivered to the circuit at the same moment it was reversed in the armature. Its effect on the curve, or wave form as it is called, would be to reverse D E F, Fig. 12, into the dotted curve D G F. There will be then a series of positive impulses like A C D delivered to the circuit D. Fig. 10, producing a pulsating E. M. F. as distinguished from the alternating E. M. F. delivered to circuit F. These are called "sine waves" because they approach or approximate the curve called the "curve of sines."

The pulsating E. M. F. is not steady enough for our present electrical apparatus. A sensitive voltmeter would vibrate so much that it would be almost impossible to obtain a reading. A sluggish voltmeter or, if the frequency was high an ordinary voltmeter, would read an average value of voltage between zero and the maximum value represented by C J. This average would be the line H K M N. One great disadvantage of the single coil in the armature is that the receiving apparatus must be insulated for a voltage equal to C J, while the working voltage is only K D.

The method of duplicating coils on the armature, as shown in a, Fig. 13, also has many disadvantages. It is readily seen that as the second coil is set at 90 degrees to the first its rise and fall of E. M. F. will come 90 degrees behind that of the first and will therefore help fill up the gap between the pulsations in the first coil. The one great trouble with this method of winding is that it is impossible to set the brushes on the neutral point; that is, the point on the commutator which is at the moment connected to the coil in which the voltage is changing. For this reason a heavy, distructive spark occurs between the brushes and the commutator segments as the brushes leave them.

Another way of winding which gives much better results, is shown at v, Fig. 13. This method is as if the original coil had been divided into two equal parts and one half turned through an angle of 90 degrees. The commutator is also cut into two more segments and the taps from the new coil brought down to them. This winding is quite different from the first in a number of ways. It will be noticed that there is a continuous path through the coil all around the armature. This shows that the winding is really one big coil with taps brought to the segments of the commutator from equidistant points in the coil. This is true of all simple wound armatures, no matter how many segments the commutator has, and it is also the principle upon which all armatures of the drum type are wound.

It would be well now to study the effect of splitting the coil on the E. M. F. generated. Fig. 12 gives the rectified E. M. F. for the one coil. By halving the coil it is evident that the E. M. F. will be one half. As the second coil is 90 degrees away, its E. M. F. will, therefore, be 90 degrees away, starting at D, Fig. 14. Now, although the maximum voltage B D would be only one half of C J, Fig. 12, the average voltage M N, and represented by the line H K, would be the same as the voltage K D and the line H N of Fig. 12.

From this can be deduced that the output of the armature would be the same whether it be wound in one big coil with a two segment commutator, or whether it is wound as many coils with as many segment commutator. The effect of increasing the coils is to reduce the voltage per coil (B D in Fig. 14) until it becomes approximately the same as M N, the average voltage of all the coils. It can be easily seen that multiplication of the wave curves A B C a few degrees apart would give nearly a straight line composed of just the wave tops.

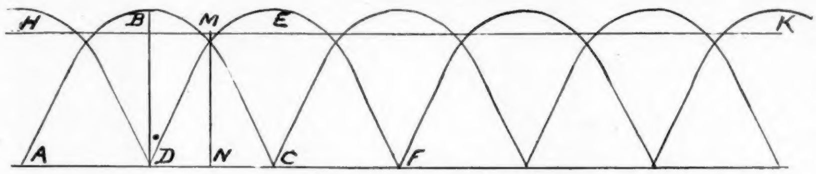


FIG. 14.

Mufflers to minimize the noise of the escape of exhaust steam from high-pressure steam engines are sometimes needed. A good muffler is made by inserting, near the engine, a chamber of 15 or 20 times the volume of the cylinder and continuing the exhaust pipe from this chamber. This will do away with the disturbance caused by steam passing through a tortuous exhaust pipe.

Mica is much used in electrical machinery, as an insulator beteween the segments of commutators. For this purpose the mica must be sott. Large sheets of mica are in demand for lamp chimneys and other novelties. Scrap mica is ground fine for fire-proofing material, as a lubricant, and for wall papers.

Comparatively little has been heard about radium this year, due to the fact that the cost of the salt is almost prohibitive, and that the experiments to date, while interesting, have proved little or nothing as to the actual value of the element.

TESTS OF INVENTION.

JOHN E. BRADY.

In a previous article it was stated that a patent cannot be properly be granted protecting the poduct of mere mechanical skill as distinguished from invention. Difficulty is frequently experienced in distinguishing between the two, and the supreme test for determining whether a particular device is the result of mechanical skill is not whether an ordinary mechanic could make the device if it were suggested to him,, but whether he would make it without suggestions save those which are prompted by his skill and knowledge of his art. For example, if a man constructs out of iron a machine which had previously been made out of wood, he does not thereby become an inventor in a legal sense, because everybody knows that any constructor can build a machine out of iron instead of wood. But, suppose that gunpowder had just recently been discovered and that the man who invented it had applied for and obtained a patent upon it. He might have claimed: "I combine saltpetre, sulphur and charcoal in a certain way, and produce a startling result," and it would be no answer, if an action for infringement were brought, for the infringer to say that every chemist could make gunpowder after he had been shown how. For. if every chemist did not have the knowledge as well as the skill, the originating of the powder constituted invention. Woodman vs. Stimpson, 3 Fisher's patent Rep. 98.

There seems to be no general affirmative rule by which to determine the presence or absence of invention in every case. In fact, the term "invention" cannot be defined in such manner as to afford any substantial aid in ascertaining whether a particular device discloses an exercise of the inventive faculty or not. But there are a number of negative rules declaring certain circumstances under which an invention cannot be claimed, which have been adopted as guides by the courts, and each of these rules applies to a large number of cases.

It is deducible from the authorities that it is not invention, the subject being the same, to find a new position for and old device, unless there is a substantial difference in the manner of its operation and some new and useful result is produced. The new machine may be an unquestioned improvement upon the prior art and may supersede the old machine in the market; it may work faster and better in the new position and yield a larger product;; nevertheless, if it be in fact the old machine, working substantially in the old way and producing substantially the same result, there is nothing upon which to predicate patentability. Thus, the placing of an electric burglar alarm on the outside of a safe instead of on the inside, as has been done long before the granting of the patent for the alleged invention, did not require invention, but disclosed mechanical skill merely and the device in the new position was not patentable. Holmes Electric Protection Company vs. Metropolitan Burglar Alarm Company, 33 Fed. Rep. 254.

It is no invention to use an old machine for a new process. The inventor of a machine is entitled to all the uses to which it can be put, including uses of which he had conceived no idea at the time of his invention. Robert vs. Ryer, 91 UU. S. 150. Parallel with this rule is the doctrine that the application of an old process to a new and analogous purpose does not involve invention, even though the new result had not before been contemplated. To illustrate: In 1883 a patent was issued to Alfred A. Cowles for an "insulated electric conductor" and a number of years later a subsequent owner of the right to use the patented insulator brought an action to restrain what was considered an infringement. Paraphrasing the language of the court, it seems that, although the art of insulating electric wires is almost as old as the art of conducting electricity for practical purposes by means of wires, it was not until electricity began to be used for lighting purposes that it became necessary that insulating material should be non-combustile. The result of the introductions of electricity for lighting purposes was that the insulating material then in use was frequently melted or set on fire and conflagrations from this cause became so common that insurance companies refused to issue policies on buildings in which the usual method of insulating wires was employed. Mr. Cowles was the first to discover that paint was the required insulator, it being practically non-combustile, and he accordingly applied for and obtained a patent upon his new process, which consisted of applying a coat of paint to a wire covered with cotton braid and then applying a second braiding directly upon the fresh paint so as to force the paint into the first braided covering and render it non-inflammable. It appeared at the trial that Edwin Holmes, referred to by the court as the "manufacturer of an electric burglar alarm," as early as 1860, had begun to cover his wires by a process similar to that of Cowles, the only difference lying in the fact that he allowed the paint to dry before putting on the second covering of braid. At that time there was no necessity for a non-combustile insulation and Holmes stated that it had not been his idea to produce such a one and that his method was no better adapted for electric light conduction than the paraffine coated-wire. It was held, however, that

Cowles had done nothing more than apply an old process to a new and analogous purpose and that, for that reason, the patent which he had been granted was void. Ansonia Brass & Copper Company vs. Electric Supply Company, 144 U. S. 11.

As a general rule, a change in the size of a machine or the parts thereof does not constitute invention, but is classed with the output of mechanical skill. It is a rule, however, which, like most other rules of law, has its exceptions. In the Edison Electric light patent, granted in 1880, the one difference between Edison's carbon filament and the earlier carbon burners of Sawyer and Man was that Edison had reduced the diameter of his filament to one-half the value of those previously made. But this reduction increased the resistance of the burner four-fold and reduced its radiating surface two-fold, thus increasing the ratio of resistance to radiating surface eight-fold. "That eight-fold increase of proportion," says Walker, in his work on the law of patents, p. 29, "enabled the resistance of the conductor of electricity from the generator to the burner, to be increased eight-fold, without any increase of percentage of loss of energy in the conductor, or decrease of percentage of development of heat in the burner; and thus enabled the area of the cross-section of that conductor to be reduced eight-fold, and thus to be made with one-eighth of the amount of copper or other metal which would be required" if the reduction of diameter of the burner had not been made. Former carbons had been found not to possess lasting qualities. While carbon burners continued to break down, even after Edison's invention, still the improvement which he made caused them to be more stable than they had ever been before. The device was held to have displayed inventiveness. the court remarking in the course of its opinion, that the difference between carbons that lasted one hour and carbons that lasted hundreds of hours was precisely the difference between failure and success. Edison Electric Light Company vs. U. S. Electric Light Company, 52 Fed. Rep. 300.

In passing upon the question of the presence of invention, simplicity in the appearance of the device is immaterial. The proposition is illustrated in the case of Colgate vs. The Western Union Telegraph Company, 15 Black, 365, which was an action founded upon letters patent granted to George B. Simpson in May, 1867, as inventor of "an improvement in insulating submarine cables." In the opinion is an interesting outline of the efforts of the inventor to obtain a patent for his invention, which covered a period of nearly twenty years, the first application being made in January, 1848, and the letters being finally issued in May, 1867. The claim of the patent was "the combination of gutta percha and metallic wire, in such a form as to encase a wire or wires, or other conductors of electricity, within the non-conducting substance, gutta percha, making a submarine telegraph cable, at once flexible and convenient." It was admitted by the defendant company that it had used submarine cables, in the insulation of which gutta percha was employed, but it was contended as a defense that it had long been known that resins and gums, as a genus of articles, were electric insulators, and that, therefore, it did not require invention, when gutta percha became known, to cover wire with it for the purpose of insulating the wire. But it was held that there was invention in the discovery of the fact that gutta percha was non-conductor particularly suitable for submarine cables. It was very easy, after the discovery had been made, to say that it was a natural conclusion that gutta percha would be an insulator from the known insulating properties of gums and resins generally. But it was also a fact that experienced men had groped about, experimenting first with one device and then with another, in fruitless effort to secure a practical means of crossing watercourses with lines of telegraph wires, until it was at length found that gutta percha was the needed insulator.—"Electric World."

METHOD OF PLATING LARGE PIECES.

Occasionally it is desirable to protect metals by plating them with copper or other metal, but this can not be done conveniently because of the large size of vat which would be necessary in order to submerge the article to be coated. To overcome this difficulty R. Goldschmidt has tried the following method, and found that it gives excellent results. It consists simply in cleaning carefully the article which is to be protected, so as to remove all dirt and grease and leave a surface suitable for plating by the ordinary process. The article is then attached to the negative pole of the source of current and an ordinary paint brush, capable of containing a considerable amount of electrolyte, is attached to the positive pole. This brush is then passed over the part which is to be plated, carefully, and as the current passes through it, a smooth, adherent, strong coating of the metal may be built up to any desired thickness. The process is easily carried out and gives results of excellent character. The author, in his experiments, used a voltage of 110, but placed a number of incandescent lamps in series with the brush, so as to limit the current to about one-tenth of an ampere. He was able to plate successively in this way silver, gold, copper and nickel, and had no difficulty in coating different parts of the same object with different metals. Nickel was found preferable for a protective coating, because of the low voltage required in the process. Details of the solutions employed are given, cyanide solutions being used for gold and silver, and sulphate solutions for copper and nickel.--L'Industrie Electrique (Paris),

BORING CORE-BOX FOR GAS ENGINE.

Perhaps the way I bored out a core box for a small gas engine is not new to all of your readers, but at the same time it may interest others, writes Yrdnal, in "American Machinist."

A 3-horse-power gas engine came to us with the base broken, something as in Fig. 1. It was a 4-cycle type, open in the base on each side over bearings. The cylinder and base were cast in one piece and patching it was out of the question, as it was too badly broken. The only way out of it was to cast a new base, so we put the cylinder in the lathe and cut it off, as in dotted lines in Fig. 1, trued the end and cut a thread on it, as in Fig. 2. Then we screwed the new base on good and tight and put in a couple of set screws to make a surer job of it. The little engine has been running constantly ever since, with no signs of loosening up.

You know how it is in a repair shop where the lathe hands have to turn patterns for the patternmaker who has no wood lathe. Well, the pattern and core box were given me to be turned; the pattern, as in Fig. 3, was easy, but all the while I had the core box in mind; I schemed a way that turned out better than I expected.

The core box had to be 3/8 inch on a side smaller than the pattern, with the same curves, so as to have an even amount of metal all around. I got the patternmaker to make me a templet of the core box as it should be when finished, as shown at T, Fig. 4. I chucked and clamped the pattern in the lathe, as shown, and of course bolted weights on the chuck to counterbalance the pattern, I then made a long offset boring tool post with the cutting point in direct line with the centers of the lathe.

On the back end of the boring tool I clamped a piece of 3/8 round iron that had one end bent and pointed. The templet was then nailed to an upright piece that I had fastened to a board and clamped to the lathe bed. I tried the templet with the back and front of the core box; also had it at the same hight as the centers of the lathe. In the first and second cuts I had to let the pointer travel at a little distance away from the templet, but on the finishing cut I just kept the point from touching it. The finished job was barely 1/16 inch out and was very satisfactory in every way. I had done other jobs using the same kind of rig, and was always successful.

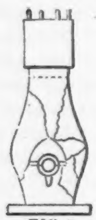


FIG. 1


FIG. 2

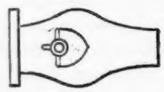
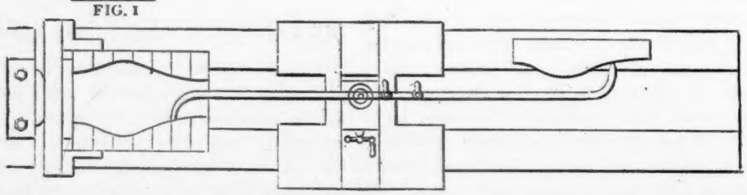


FIG. 3



VAPORIZING GOLD.

Professor Moissan, in vaporizing gold in the electric furnace, find that 100 to 150 gr. can be evaporated in two or three minutes. By condensing the gold vapor on a cool surface, either filiform masses or cubical srystals can be obtained. It is found that gold, like copper and iron, dissolves a certain amount of carbon when in the liquid state, but this separates out as graphite on cooling. Gold is to be found less volatile than copper. The properties of distilled gold are the same as those of hammered gold, or the melted metal reduced to a ne powder. When an alloy of copper and gold is distilled, the vapor of copper comes over first, showing that there is no definite compound. In case of alloys of gold and tin, the latter metal burns in contact with air. This tin oxide is found to be of a purple color, due to a deposit of fine gold on its surface.

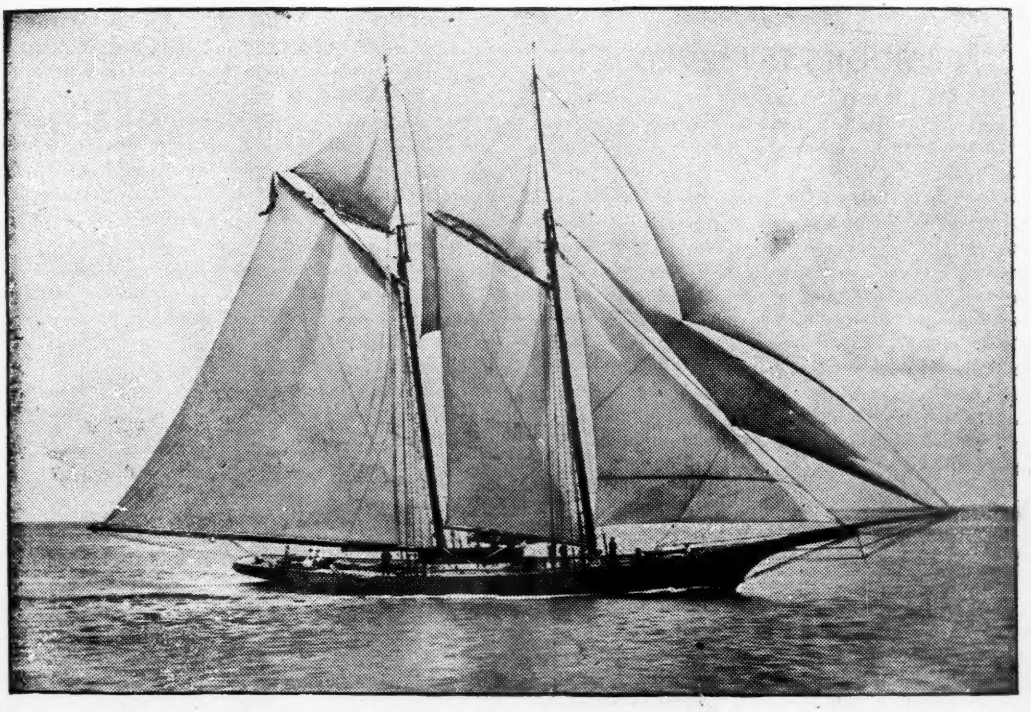
Many rivers- especially in broad valleys, are bordered by a terrace or plain, there being sometimes two or more, extending like a series of shelves, or steps, up the valleyside. The lowest of these is often covered by the river during periods of high water, and is consequently termed the flood-plain.

FIRST PHOTOGRAPH OF THE YACHT AMERICA UNDER SAIL.

Probably no American yacht has been oftener pictured than the famous schooner America, yet the negative of the rst photograph made of her while under way is preserved in Boston today.

It was made nearly 24 years ago, in 1883, when the photographing of moving objects was a novelty.

N. L. Stebbins, the veteran photographer of Boston, was a pioneer in photographing vessels under sail, making his rst pictures of that kind in the spring of 1883.



Gen. Butler then owned the America, which h had bought in 1873 at an auction sale at Annapolis, where, since the war, the celebrated yacht has been stationed. His sailing master was Capt. James H. Reid, a Boston branch pilot, who hearing that Mr. Stebbins could photograph a vessel in motion, called on him, and arranged to have a picture taken of the America.

Mr. Stebbins went down the harbor on a tug, and off Boston Light Capt. Reid put the America through her paces, in a moderate breeze, with all her light sails on.

"The picture was one of the wonders of the times," said Mr. Stebbins recently. "People had never seen anytning like it before. It had been customary up to that time to tie a vessel up fore and aft if she was to be photographed with her sails up. Of course the work could be done only in calm weather, and the picture didn't look very spirited. I was the first photographer to get results with photographs of vessels in motion."

The picture herewith was made from a print taken by Mr. Stebbins a few days ago from his original negative, which is still in good condition.

It is interesting to yachtsmen from a technical standpoint, as it shows the winner of the America cup in a rig which she no longer carries. This rig was given her in 1880, when she was rebuilt from plans by Edward Burgess, and was carried until 1885, when the headrig shown here was discarded and a pole bowsprit was put in.

When built, in 1851, the America was rigged with but one topmast. Her sail plan was considerably narrower on the base than the one shown here, though her masts were taller. When she left this country for Europe she carried no flying jibboom, and had but three sails, mainsail, foresail and jib.

For the great race at Cowes, Aug. 22, 1851, she was tted with a flying jibboom and flying jib, which were carried away i the race, to the satisfaction of "Old

Dick" Brown, her skipper, who said he didn't believe in flying jibs, anyway.

When Gen. Butler bought the America she had a rig given her by the government in 1870, when $20,000 was spent on her to t her for the first race in this country for the America cup, the challenger being the English starters.

The America now lies at Chelsea bridge. She has not been in commission since 1903. The last good photograph of her under sail was made in 1901, off Newport.

The famous old craft is now registered in the name of Paul Butler, having been in the Butler family since 1873. With an overhaul and slight repairs to her topsides, she would be good for several years more of service.

BOOKS RECEIVED.

PRACTICAL UP-TO-DATE PLUMBING. George B. Clow. 264 pp. 7 1/2x5 inches, 250 illustrations. Cloth, $1.50. Frederick J. Drake & Co., Chicago, Ill.

Plumbing is today a subject of much importance in every building, whether used as a residence, office or factory. It is essential that work of this kind be properly designed and installed; in fact, the regulations in many cities and towns are quite rigid in their requirements. In this book the subject is very completely presented, and the many kinds of fixtures and their uses are shown by means of numerous illustrations and suitable text. The apprentice who is learning the plumbing trade and the young journeyman, as well as the mechanic to whom such knowledge is desirable, will find this book very helpful.

MODERN AMERICAN LATHE PRACTICE. Oscar E. Perrigo, M. E. 444 pp. 9x6 inches, 314 illustrations. Cloth, $2.50. The Norman Henley Pub. Co., New York.

The variety of attachments and movements to be found on the modern lathe, and with which the mechanic and the engineer must of necessity be familiar, give to the book its special value, as the contents relate almost entirely to descriptions of the more prominent makes of lathes. Very complete and illustrated descriptions of the various parts of the lathe, attachments, rapid change gear and tools are given, as well as some excellent directions for testing a lathe. There are also chapters on high speed, special and turret lathes together with an interesting history of their development.

HENLEY'S RECEIPTS, FORMULAS AND PROCESSES. Edited by Gardner D. Hiscox, M. E., 787 pp. , 9x6 inches. Cloth, $3.00. The Norman Henley Pub. Co., New York.

In compiling this book the editor has endeavored to meet the wants of the mechanic, manufacturer, artisan and the housewife. Much care has been taken in selecting the materials from reliable sources, and the editor has endeavored to discard anything of questionable merit. In connection with the matter, the particular application is given wherever possible, thus enabling the reader to select the formula best adapted to his needs. The matter is arranged alphabetically under general headings, under which are grouped all the information appertaining thereto. Numerous cross references are given to facilitate the finding of specific information, or that relating to any particular class. As a reference book for public libraries or for anyone engaged in general experimental work the book would be of much value.

MODERN HOT WATER HEATING STEAM AND GAS FITTING. William Donaldson. 244 pp. 7 1/2x5 inches. Cloth, $1.50. Frederick J. Drake & Co., Chicago, Ill.

The owner of a building, whether it be a esidence or one of larger size, may find it to his interest to know something of the subject treated by this book. Many a mechanic could make his home more comfortable during the winter months by installing a steam or hot water heating apparatus, and is only deterred from doing so by the lack of knowledge of details of the work. From this book can be obtained a working knowledge of modern systems and their proper installation, making it possible for an owner to determine whether work was being properly done, or for a mechanic to equip his own home at a very considerable saving in the cost. It is also a valuable bok for the apprentice or workman who desires a general knowledge o fthis branch of work.

BEGINNING WOODWORK. Clinton S. Van Deusen, M. E. 99 pp. 6x9 inches, oblong. 10 illustrations by E. V. Lawrence. Cloth, $1.00. The Manual Arts Press, Peoria, Ill.

This book is intended as a definite statement of steps that may be followed by a beginner in learning the fundamental principals of woodworking. This is accomplished by a number of specific examples, and from the experience gained in doing these the pupil should be able to accomplish without difficulty other work of which the examples given stand as types. The number of examples given is so small, however, that the beginner must seek other sources of information before his appetite for designs is likely to be satisfied. As a suggestion for future editions, an appendix of about a dozen designs with dimensions would be recommended as rounding out the book. The information given is clearly expressed and the illustrations are well done.

In the early days of tunneling, machine drills were mounted on cars running on tracks, and this is still the practice in some parts of Europe.

A WARSHIP ON LAND 45 YEARS.

Next to the much-beloved frigate Constitution, the old ship of the line Granite State is the oldest vessel in the navy on the active list.

Quite singular and interesting are the facts in connection with the construction of this old craft. Like the Constitution, the Granite State is a New England product. The former was built at Boston and the latter at Portsmouth, N. H., by the government. Just after the Constitution made history by her famous engagement with the frigate Guerriehe in the war of 1812, congress decided in favor of a bigger navy, expecting a prolonged war with Great Britain. Plans were made for the construction of a number of ships ready to meet the emergency. One of these was the Alabama, now the Granite State.

The war having ended in 1815, the rush was over. Plans for the contemplated ships were already made, however, and early in the year 1819 work was commenced on the Alabama. Just 45 years later the famous ship of the line was launched. This undoubtedly is a unique incident in the history of the United States navy.

Why was one-half of her career spent on dry land?

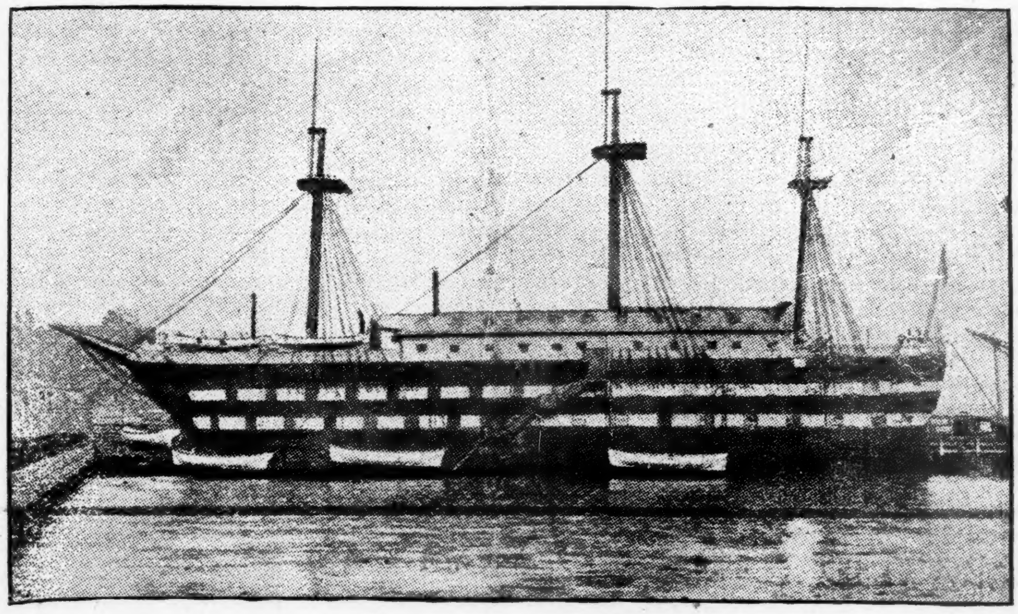
First, appropriations for the navy had become exhausted; second, there was no necessity for a big navy, the nation being at peace nearly 50 years, except for the Mexican war.

Care was taken of the old Alabama, while she remained in the stocks, but when she was launched on Jan. 23, 1864, she was of little use as a fighting ship.

Another notable circumstance connected with her was that on October 28, 1863, a few months before her launching her name was changed from Alabama to New Hampshire. This was due to the fact that the state of Alabama has seceded from the Union and had espoused the cause of the confederacy. Changing her name gave another New England state a proper representation in the navy.

A few months after the New Hampshire was launched she was tted out for a year's cruise and went to sea on June 15, 1864, four days before the famous fight between the Kearsarge and the confederate shop Alabama. From the latter part of 1864 up to 1866 the New Hampshire was used as a storeship, attached to the South Atlantic blockading squadron at Port Royal. From 1867 to 1875 she was used as receiving ship at the Norfolk navy yard. In 1877 she was again assigned to duty as a storeship at Port Royal and remained there until 1881.

In 1882 she went to Newport, R. I., and for the next eight years was used as a training and receiving ship for boys. For the next two years she was stationed at New London, Conn., as a receiving ship. Her final assignment was in 1893, when she was turned over to New York state for the use of the naval militia. There



she remained until a few weeks ago, when se was succeeded by the cruiser Newark.

In 1903, when the 10,000-ton battleship New Hampshire was authorized by congress, naval officials deemed it unwise to have two ships in the navy bearing the same name. On Nov. 30, 1904, the name of the old New Hampshire was changed to Granite State, this being the third name given her.

The Granite State is 196 feet 3 inches in length, 53 feet in width, with a mean draft of 25 feet 6 inches. She was originally of 26oo tons displacement and carried 15 guns.

Today she is a fine old hulk of a type famous at the time of the beginning of her construction. She is still sound for inshore cruising. Since she was loaned by the government to the New York naval militia certain enlistd men have been attached to her as caretakers. As she stands today, without any assignment, she is in danger of being discarded from the active list of vessels and sold for junk. Interest, however, will be taken in her by Admiral Dewey and other leading naval officers, who believe in the preservation of these old hulks as naval museums. No craft ever built for the navy, it is believed, has ever had as odd a career in the navy as the Granite State.

NEW TELEGRAPH RAILWAY SIGNAL.

The attention of railroad men has been attracted to the telegraph railroad signal for the manufacture of which the Telegraph Signal Company has been organized at Rochester, N. Y. The signal is the invention of Selden R. Whight, a railroad telegrapher. It is essentially an emergency device, primarily for use on single track railroads, and is intended to place the control of semaphores at the several stations under the control of the dispatcher. By means of this signal the dispatcher may throw a semaphore to "stop position" at any desired point, regardless of the condition of the operator's instrument at that station, that is, whether or not the key of his instrument on the dispatcher's wire is open. The signal instruments form part of the operator's apparatus at each station, the relay being used to operate the semaphores and bell signal. The signal devices at all stations are identical. Each instrument is provided with an accurate and unfailing selector which enables the operator to select not only the required station but the particular semaphore which he wishes to operate. For each station there are three contacts on the selector drum—one for the first semaphore, one for the second and one for a bell signal.

Briefly, the signal operates in this way: If the dispatcher wishes to throw, say, the east bound semaphore at a station he would hold the key of his instrument open 50 sec. At the expiration of 40 sec. a contact would be made which would cut out the keys at every instrument on the circuit. At the end of 50 sec. contact would be made through another contact point, which would enable the dispatcher to operate the selector. By means of his key the dispatcher would step the selector to the number of the semaphore which he had selected to throw and wait 20 sec. At the end of that period the semaphore would be thrown to "stop position," and a messenger call signal would apprise him of the fact. Closing the key a few seconds later would restore all of the signal devices at all of the stations to normal, leaving the interlocking semaphore to be drawn to safety position when everything was clear. The other semaphore or bell signal would be operated in a similar way.

MALLEABLE CAST IRON.

When properly made malleable cast iron should have a tensile strength of 42,000 to 48,000 lb. per square inch, with an elongation of 5 per cent. in 2 in. Bars 1 in. square, and on supports 12 in. apart, should show a transverse strength og 2,500 to 3,500 lb., with a deflection of at least 1/2 in. The resilience should be at least eight times that of cast iron. Malleable cast iron can be bent, twisted, and abused very much before giving way, thus making ideal for service where a fair tensile strength is required, but especially where often repeate! shocks are th rul.

Whil the strength of malleable cast iron should be as given above, much of it will fall as low as 35,000 lb. per square inch, and this will still be good for such work as pipe-fittings, hardware castings, and the like, where a certain amount of punishment can be expected, and cracking should not take place. On the other hand, this material can be made exceedingly strong, even 63,000 lb. per square inch having been reached, as well as a deflection of 2 1/2 in. on the transverse test, with oftentimes 5,000 lb. to cause rupture. This, however, is not desirable, as the softness of the casting is sacrificed in this way, and its resistance to continued shock lessened.

The process of making malleable cast iron may be briefly summarized as follows:—The proper irons are melted in eithe the crucible, the air-furnace, the open-hearth furnace, or the cupola. The metal when cast into the sand moulds must chill white or not more than just a little mottled. After rolling off the sand from the hard castings they go into the annealing department, where they are packed in puddle scale, or other materials containing iron oxide, and here subjected to a period of red heat (1,250° to 1,350° Fahr.), over 60 hours after reaching the proper temperature. They are then cooled gradually, rolled again to remove adhering scale, chipped or ground, straightened, and shipped away.

Pennsylvania alone produced last year nearly three-quarters of a million tons pig iron more than the whole of Great Britain.

THIN NEGATIVES IN THE ASCENDANT.

JAMES THOMSON.

That the ultimate purpose,—the end of all photographic endeavor insofar as the average amateur is concerned, is the pictorial expression,—the arrangement of lights and darks in what is commonly spoken of as "the print" would seem to be conceded. Furthermore, the negative that best serves our purpose is the one to use quite regardless of appearance or whether in technical excellence it is one to claim admiration. The clear, crisp, transparency-like qualities in a negative usually appeal to the beginner, nor are there wanting photographers who ought to know better who talk of such a result as one to emulate.

For many a long day was the novice misled in being taught to consider the negative the end rather than the means to an end. As for myself I remember more than one authority who constantly impressed upon the beginner the importance of developing the snapshot (as a rule notoriously undertimed) in solutions stronger than normal. Also to carry the process to the extent of entirely burying the image until all was an even blackness.

Starting with such wrongful instruction, and absorbing the idea that the negative of density, with clear glass shadows, alone constituted the "Ultima Thule" as regards plate deelopment in the realm of photogphy, it is small wonder it took the misdirected a considerable time to realize their mistake.

In my own case I soon discovered my error, but a friend of mine never did, and today continues to overdevelop his negatives and in the case of non-halation plates simply went to a ridiculous extreme. Many a good pyro developed negative he has thrown in the dump without ever printing a proof because thoroughly convinced from much reading of wrong instruction books that such a negative was too thin. Continually, and persistently, overdoing the business with ordinary plates, and reading that non-halation plates required to be carried further in development, he did so to the extent of burying the image completely, producing a negative, a time exposure so dense, it took a professional printer a full half a day to print from it. There are many like him so accustomed to the blackened, all-over, dense negative, they simply cannot believe a thin one though full of detail can possibly answer requirements. Most of these people have been alone familiar with the negatives developed through stock houses and the like who rarely use pyro.

Fortunately we have today got beyond the fallacy in question, and for much of our enlightenment we must thank present day pictorialists. We, most of us, concede now that the remedy for both over and under exposure is the same,—development in dilute solution as to preserve all possible detail which by the old time forcing system of the under-timed snapshot was a thing quite impossible.

Regardless of appearance the "perfect negative" for anyone is of necessity that which best carries out our pictorial purpose. Nor is it generally the one with the sharpest image and clearest shadows that will do so. While the backed plate is an advantage in a considerable, or many, subjects there are cases where it is clearly a detriment. For certain effects halation is to be sought rather than avoided, in fact a good many photographers would be the better for a reduction in sharpness. For white dresses, snow scenes, trees against the sky and such, the backed or non-halation plate is decidedly in order. In the case of many low-toned subjects where extremes of contrast are lacking the unbacked plate will answer quite well.

In counter lighting, working into the sun, where the scheme calls for atmosphere in abundance, there is not the slightest necessity for the backed plate. The blackened tree trunks,—usually in such scenes too much in evidence,—will be none the worse for a little spreading of the light. Why, have all not heard how the old time photographers were accustomed to intentionally fog the shadows by exposing the plate either before or after taking the picture, to the light of a match. Such a scheme might do no harm at the present day in the case of some landscape pictures that come our way when all in the shadow is as black as night. While the exposure to a lighted match would not furnish lacking detail, were pictures from such negatives printed on rather rough paper the halation in the shadows might be made to answer for it.

The thin negative with all possible detail is without doubt in the ascendent and for some of the best papers on the market its use is imperative. Workers who are still wedded to contrast, or those who habitually overdevelop should mend their ways, for artistic work is not thus possible. Professionals we can plainly see as the overdeveloped negatives in the whitewashy appearing but the beautiful texture of human flesh is completely lost in density. It is quite easy to distinguish the oerdeeloped negatives in the whitewashy appearance of the resultant prints, more especially when in a black and white medium.

By thin negative one does not necessarily mean a flat one. In the pyro developed negative contrast is present though to those accustomed to the use of the modern reducers such as metol it might not seem to be the case. The property developed negative when our old friend pyro is the reducer will look rather thin but under the pinting light it will develop an astonish-

ing amount of contrast and pluck.

Once all possible gradation has been secured we gain nothing by piling up density. We simply slow the printing and where there is a stain of a pronounced character we doubtless impair the quality of the image. Many a well blackened negative gives a surprisingly limited degree of contrast, the blue color permitting the light to pass without leaving the record of gne half tone in the image.

The forcing process in deevlopment in hope of gaining detail is foolish. Once the detail has ceased to grow in the shadows we may as well consider the job done, for no amount of forcing will then alter the steepness of gradation. No more can we force out detail in a plate than we can in a velox print and in the latter we but dirty the whites by prolonged development.

We cannot help but see the detrimental result where gaslight papers are involved, and it should carry a lesson to those who continually and persistently overdevelop plates and films.

In my own practice I have found Carbutt's Pyro-soda formula a good one because of its elasticity, and the getting of the full strength of the reducer by using the dry pyro, adding it just before starting to develop. The formula I employ is as follows:

CARBUTT'S PYRO-SODA DEVELOPER.

Sulphite of soda, dry ....3/4 oz.
Carbonate of soda, dry .... 1 oz.
Hot water .... 10 ozs.

Weak solution 1 to 10, medium solution 1 to 8, strong solution 1 to 5, and from 1 to 3 grains of the dry pyro to each ounce of solution used.

In my own practice with fully timed exposures I employ 1 to 8 and 2 grains of the dry pyro to the ounce.

Where there is a great deal of white in the composition, snow scenes, white dresses or white flowers, start in a dilute solution, 1 to 16 with 1 grain of pyro to the ounce, and when detail is well out if not sufficiently dense immerse in the full strength until opacity is obtained. Where more yellow stain is wanted, use but a half an ounce of the sulphate instead of three-quarters as stipulated. A slight yellowness of the film I hold is an advantage, the slightly stained negative making a much better printer.

Some who object to pyro for the reason that everything it touches is apt to get stained may find in ortol a satisfactory substitute, using the same quantity of the yowder as recommended for pyro. A good metol-hydro developer is as follows, though with that a much more opaque negative will be required on account of the blue-black nature of the image which allows for the light filtering through much more than with some other reducers.

METOL-HYDRO DEVELOPER.

Solution A.

Metol, 32 grains.
Hydro-quinone, 32 grains.
Sulphite of soda (dry), 120 grains.
Water, 16 ounces.

SSolution B.

Carbonate of soda (dry), 120 grains.
Bromide of potass, 15 grains.

To develop take one part each of A and B and an equal quantity of water. When there is too much contrast simply dilute still further or use a less quantity of solution A.—"Western Camera Notes."

SCIENCE AND INDUSTRY.

Concrete is a troublesome material in which to drill deep holes; it is a good plan to use water under pressure, with a wide flare bit, permitting a small copper waterpipe to be inserted nearly to the bottom of the hole, so that chips and dust are carried off before they can wedge the bit.

Plasticity may be defined as the property which many bodies possess of changing form under pressure, without rupturing, which form they retain when the pre-out rupturing, which form the retain when the pressure ceases, it being understood that the amount of pressure required, and the degree of deformation possible, will vary with the material.

A stream of water can be thrown vertically 103 ft. and horizontally 9** ft., with a pressure of 100 lb. at the nozzle and 1 3-8 in. diam. The nozzle will discharge 674 gal. of water per minute. With a higher pressure, equivalent to a higher head, the amount discharged and the distance to which the water may be thrown will be increased.

Over 50,000,000 gal. of water are pumped out of the anthracite coal mines of Pennsylvania every day in the year. The exact average for 1905 was 633,000,000 gal. per day. Nearly 1,000 powerful engines, delivering from mine bottom to surface 500,000 gal. of water per minute, are required. Mines may be shut down and coal production suspended, but the water flows on forever. The cost of removing it is one of the important items of expense that make up the price of anthacite.

Whether a high-power or a low-power explosive is to be used in blasting, is dependent largely upon the use to which the rock is to be put, as well as upon the strength of the rock itself. Black powder, with its comparatively slow, heaving action, is used where the material is quite friable, as in mining coal or galena, or in excavating shale, hardpan, and similar material. A high-power explosive like dynamite is invariably used in tunnel-driving, shaft-sinking, and open-cut work in tough rock. It cannot be used for quarrying dimension stone, as it shatters the rock.

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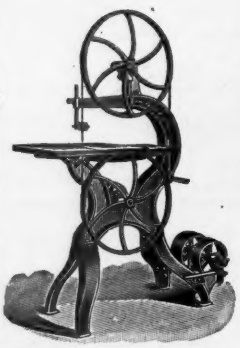

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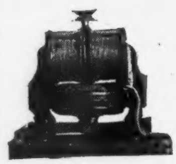

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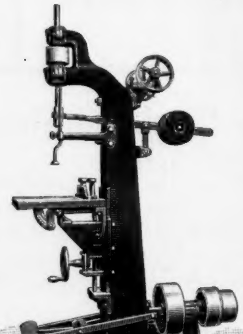

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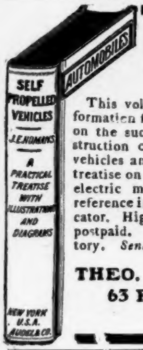

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